



**US Army Corps
of Engineers**
Waterways Experiment
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Technical Report EL-96-14
September 1996

Environmental Impact Research Program

Managing Historic Properties in Drawdown Zones at Corps of Engineers Reservoirs: Three Case Studies

*by Robert A. Dunn, Lawson M. Smith,
Hollis H. Allen, Hugh M. Taylor*

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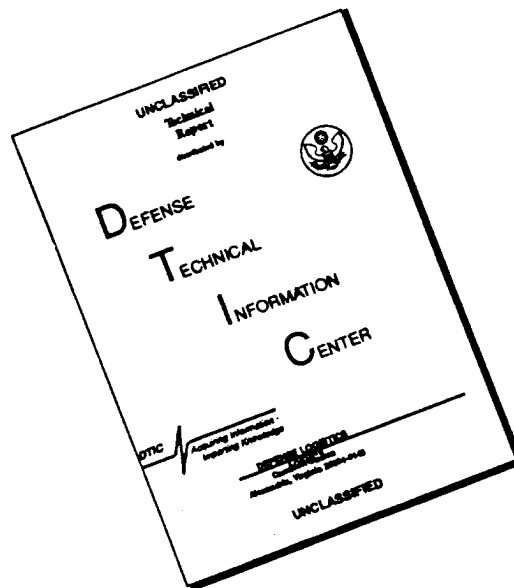
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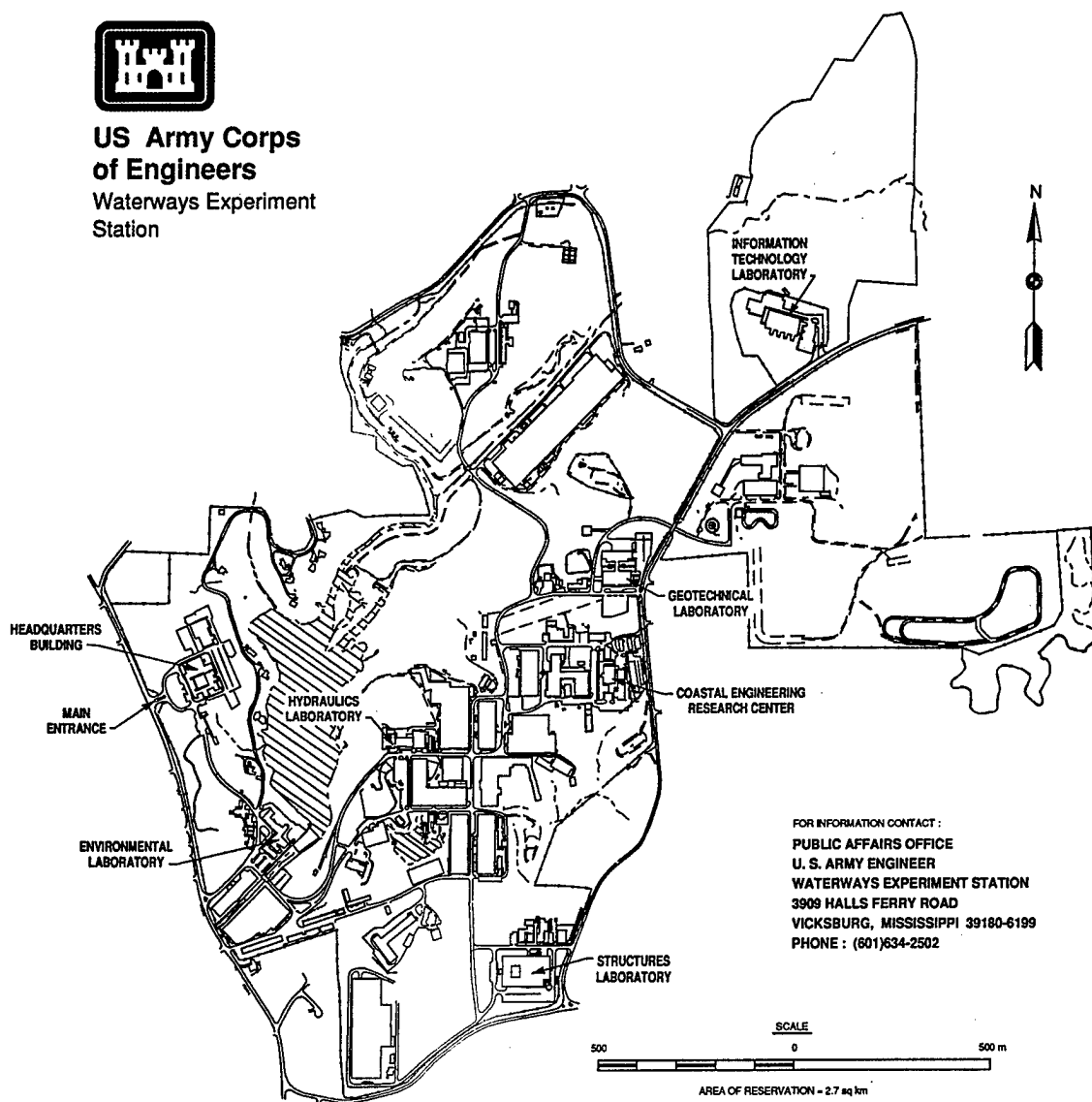
U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

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**US Army Corps
of Engineers**
Waterways Experiment
Station



Waterways Experiment Station Cataloging-in-Publication Data

Managing historic properties in drawdown zones at Corps of Engineers Reservoirs : three case studies / by Robert A. Dunn ... [et al.] ; prepared for U.S. Army Corps of Engineers.

166 p. : ill. ; 28 cm. -- (Technical report ; EL-96-14)

Includes bibliographical references.

1. Historic buildings -- Conservation and restoration. 2. Historic sites -- Management. 3. Reservoir drawdown. I. Dunn, Robert A. II. United States. Army. Corps of Engineers. III. U.S. Army Engineer Waterways Experiment Station. IV. Environmental Laboratory (U.S. Army Engineer Waterways Experiment Station) V. Environmental Impact Research Program (U.S.) VI. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; EL-96-14.
TA7 W34 no.EL-96-14



US Army Corps
of Engineers
Waterways Experiment
Station

Environmental Impact Research Program

Techniques for Effective
Management of Historic
Properties on Lakeshores
and in Drawdown Zones



Managing Historic Properties in Drawdown Zones at Corps of Engineers Reservoirs: Three Case Studies (TR EL-96-14)

ISSUE: The U.S. Army Corps of Engineers (COE) is required by Federal law and by its own regulations to protect "historic properties" (archaeological sites eligible for the National Register of Historic Places) from adverse impacts or to mitigate adverse effects through data recovery, site stabilization, etc. Sites located within the drawdown zones at COE reservoirs are being adversely affected by fluctuating water levels caused by normal reservoir operation. Seasonal drawdowns cause a variety of erosion-related impacts and expose sites to human vandalism. Strategies must be devised to prevent or mitigate adverse impacts to these significant cultural resources.

RESEARCH OBJECTIVE: The major objective of this research work unit is to provide archaeologists and lake managers with the tools for more effective management of historic properties within the fluctuating drawdown zones of Corps reservoirs. The techniques and methodologies developed can be incorporated into project operation and maintenance manuals and Historic Preservation Management Plans. The research goal is to move beyond crisis management into thoughtful stewardship of the cultural resources under Corps control. To achieve this requires better delineation of the overall problem and clear guidelines for the treatment of such properties, including long-term monitoring plans, data recovery options, and the use of effective site preservation techniques.

SUMMARY: Two technical reports have been produced for this work unit. The first report, "Impacts to Historic Properties in Drawdown Zones at Corps of Engineers Reservoirs," deals with the nature and occurrence of impacts to historic properties along the shorelines and in the drawdown zones of the COE reservoirs. It presents the survey questionnaire responses obtained from all

Corps Districts and describes the management practices observed in field visits to nine Corps reservoirs. This second report attempts to identify techniques for the effective management of historic properties (National Register eligible) which are annually subjected to impacts from reservoir drawdowns. Much of the discussion focuses on three case studies which were conducted at three Ohio River Division reservoirs during the winter drawdown period of 1996. The Corps reservoirs included Barren River Lake, Kentucky (Louisville District); Bluestone Lake, West Virginia (Huntington District); and Allegheny Reservoir, Pennsylvania and New York (Pittsburgh District). Management techniques observed at the nine Corps projects visited in 1995 are also discussed. Additional information on proposed management techniques has been incorporated from sponsored research now under way at the U.S. Army Engineer Waterways Experiment Station for other Corps Districts. Site evaluation strategies, cultural resources monitoring plans, the mitigation of adverse effect through the combined use of archaeological data recovery and site protection, the direct and indirect control of vandalism, and the preparation of drawdown zone protection plans are some of the major topics addressed.

AVAILABILITY: The report is available on Interlibrary Loan Service from the U.S. Army Engineer Waterways Experiment Station (WES) Library, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199; telephone (601) 634-2355.

To purchase a copy, call the National Technical Information Service (NTIS) at (703) 487-4650. For help in identifying a title for sale, call (703) 487-4780. NTIS report numbers may also be requested from the WES librarians.

About the Authors: Mr. Robert A. Dunn is an archaeologist at the WES Environmental Laboratory. Dr. Lawson M. Smith is a geomorphologist in the Geotechnical Laboratory at WES. Mr. Hollis H. Allen is a biologist in the Environmental Laboratory at WES. Mr. Hugh M. Taylor is a civil engineer in the Geotechnical Laboratory at WES. Point of contact is Mr. Dunn, telephone (601) 634-2380.

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Preface

The study herein was conducted as part of Work Unit 32881, entitled "Techniques for Effective Management of Historic Properties on Lakeshores and in Drawdown Zones," of the Environmental Impact Research Program (EIRP). The EIRP is sponsored by Headquarters, U.S. Army Corps of Engineers (HQUSACE), and is managed by the Environmental Laboratory (EL) of the U.S. Army Engineer Waterways Experiment Station (WES). Program Monitors were Ms. Cheryl Smith, Mr. Forester Einarsen, and Mr. Frederick B. Juhle, HQUSACE. Technical guidance and review were provided by Dr. Frederick L. Briuer and Mr. Roger Hamilton, EL, and by Dr. Clay Mathers, National Research Council Post-Doctoral Fellow in EL. Technical support during the fieldwork phase and co-authorship of the case studies analyses was provided by Dr. Lawson Smith, Geotechnical Laboratory (GL), Mr. Hollis Allen, EL, and Mr. Hugh Taylor, GL. Dr. Russell F. Theriot, EL, serves as the EIRP Program Manager.

Dr. Paul R. Nickens proposed the research to the Field Review Group of the EIRP in the spring of 1993 and served as Principal Investigator until his departure from WES in February 1994. Since November 1994, Mr. Robert A. Dunn has served as Principal Investigator. Mr. Dunn was also an author of this report.

The study was conducted under the general supervision of Dr. Robert M. Engler, Chief, Natural Resources Division, EL; and Dr. John W. Keeley, Director, EL.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

This report should be cited as follows:

Dunn, R. A., Smith, L. M., Allen, H. H., and Taylor, H. M.
(1996). "Managing historic properties in drawdown zones at
Corps of Engineers reservoirs: Three case studies," Technical
Report EL-96-14, U.S. Army Engineer Waterways Experiment
Station, Vicksburg, MS.

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Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurements used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
acres	4,046.873	square meters
feet	0.3048	meters
inches	2.54	centimeters
miles (U.S. statute)	1.609347	kilometers

1 Introduction and Background

The research work unit "Techniques for Effective Management of Historic Properties on Lakeshores and in Drawdown Zones" was successfully proposed to the Field Review Group of the Environmental Impact Research Program in the spring of 1993. As originally conceptualized, the "drawdown work unit" had the objective "to provide cultural resource specialists and lake managers with the tools to undertake effective management of historic properties located within the fluctuating drawdown zones of Corps lakes."

To achieve this overall objective three research goals were proposed. These included the following:

- a. Delineation of the overall problem, especially in terms of methods for improved impact assessment and quantification of effects.
- b. Development of techniques for efficient identification and evaluation of affected historic properties.
- c. Preparation of guidelines for treatment of such properties, including monitoring, data recovery, and preservation options.

Two technical reports were planned. The first report would define the scope of the drawdown management problem within the Corps. The second report would provide specific guidelines and examples of effective management techniques for historic properties located in drawdown zones. Preliminary plans were also made for a U.S. Army Engineer Waterways Experiment Station (WES)-sponsored workshop on the drawdown problem to be held in Fort Worth, TX, at the end of the first year of research. Due to reduced funding for the second work year and the departure of the original Principal Investigator in February 1994, the proposal for a national workshop on the drawdown problem had to be discarded.

In January 1995, work did begin on the first technical report. A survey questionnaire was prepared by the author and distributed to all 37 Districts

within the U.S. Army Corps of Engineers, and information copies were sent to the 14 Corps Divisions. The results of that survey questionnaire and the field visits it generated form the nucleus of the first technical report, "Impacts to Historic Properties in Drawdown Zones at Corps of Engineers Reservoirs" (Dunn 1996).

That first report confirmed the hypothesis that impacts to historic properties in drawdown zones were severe in their effect and a major compliance problem for every lake manager within the Corps. It also provided an accurate description of the types of impacts that can occur in reservoir fluctuation zones and the baseline condition for cultural resource management (CRM) for this specific class of sites.

Dunn (1996) demonstrated that historic properties in drawdown zones at Corps reservoirs are continuing to be destroyed by erosion and vandalism and that the problem is geographically widespread, affecting every Corps District that manages reservoirs. Seven specific management problems within the Corps were identified:

- a. Within the Corps of Engineers, there was a lack of "Baseline Funding" for the management of historic properties (National Register eligible) within drawdown zones. Such funding is essential so that impacts that occur annually can be dealt with annually.
- b. There was an insufficient emphasis on site evaluation (Phase 2 testing). The consequence of this is a paralyzing uncertainty over which sites warrant future management, protection, and mitigation of adverse effect.
- c. There was a general lack of emphasis on the preparation of Historic Property Management Plans (HPMP) and a specific lack of emphasis on the drawdown zone problem within completed HPMPs.
- d. There was insufficient manpower and a lack of procedural guidance on law enforcement options for the effective enforcement of the Archeological Resources Protection Act of 1979 (ARPA) and Title 36.
- e. There was a lack of training on the part of cultural resource coordinators at Corps reservoirs and insufficient utilization of available Corps expertise on site protection and stabilization.
- f. There was a lack of site monitoring, both in planning and implementation, to ensure the long-term protection and preservation of historic properties.
- g. There was an ineffective use of indirect management techniques to control visitor behavior.

Emphasis now will shift from defining the scope of the drawdown problem to identifying possible solutions. This report will attempt to identify techniques for the effective management of historic properties that are annually subjected to drawdown impacts. Much of the discussion will focus on three case studies that were conducted at three Ohio River Division reservoirs during the winter drawdown period of 1996. The case studies include the following Corps reservoirs:

Barren River Lake, Kentucky (Louisville District)
Bluestone Lake, West Virginia (Huntington District)
Allegheny Reservoir, Pennsylvania and New York (Pittsburgh District)

Effective management techniques observed at the nine Corps projects visited by the authors in 1995 are also discussed. Additional information on proposed management techniques has been incorporated from research now underway at WES for the Corps' Walla Walla, Portland, and Seattle Districts. Dr. Lawson Smith serves as Principal Investigator for this North Pacific Division-sponsored research. Site evaluation strategies, cultural resources monitoring plans, the mitigation of adverse effect through the combined use of archaeological data recovery and site protection, the direct and indirect control of vandalism, and the preparation of drawdown zone protection plans are some of the topics addressed in this report.

2 Field Visits

1995 Field Visits to Nine COE Reservoirs

The 15 Corps Districts that completed the survey questionnaire on draw-down impacts nominated 24 projects for field visitation and follow-up study. Nine reservoirs were eventually selected for initial field visits. The paramount selection criterion was that the reservoir contained historic properties in its drawdown zone that were being affected by fluctuating pool levels. As defined in Engineer Regulation (ER) 1130-2-438, "historic properties" are archaeological sites (prehistoric or historic in age) that are eligible for inclusion in the National Register of Historic Places.

The first field visit, Vicksburg District's Grenada Lake in Mississippi, was conducted in late April 1995. During the period from early June through mid-August 1995, eight additional reservoirs with National Register eligible sites located in the reservoir's drawdown zones were visited. In chronological order they included the following:

- Wright Patman Lake, Texas
- Lake Eufala, Oklahoma
- Lake Barkley, Tennessee and Kentucky
- Barren River Lake, Kentucky
- Bluestone Lake, West Virginia
- Allegheny Lake, Pennsylvania and New York
- Mansfield Hollow Lake, Connecticut
- Ball Mountain Lake, Vermont

Prior to visiting the selected reservoirs, a memorandum was prepared and sent to the project managers. This was done subsequent to extensive telephonic coordination with the District archaeologist or District point of contact for cultural resource management. Figure 1 illustrates the approach taken with these initial field visits. Detailed discussions on these site visits appear in the first work unit report (Dunn 1996:46-63). Much of the discussion of management practices in the present report will be based on what was observed during these visits.

MEMORANDUM FOR SEE DISTRIBUTION

DATE: 7/10/95

SUBJECT: Initial Field Visits/Interviews for Research Work Unit 32881 "Techniques for Effective Management of Historic Properties on Lakeshores and in Drawdown Zones"

1. The Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station (WES), is investigating impacts to archaeological sites which occur as a result of reservoir drawdowns. To aid Corps archaeologists in more effectively managing these cultural resources, the WES has undertaken a research program with the following goals:

a. Better delineation of the problem, especially in terms of methods for improved impact assessment and the quantification of effects.

b. Techniques for efficient identification and evaluation of historic properties (those eligible for the National Register of Historic Places) affected by drawdowns.

c. Guidelines for the treatment of such properties, including monitoring, data recovery, and preservation options.

2. Based on your District's responses to our questionnaire and the recommendation of your District Archaeologist your project has been selected for an initial site visit. This visit will consist of two parts. First, a short meeting will be held in the resident office during which time your current management practices will be discussed and the potential for a more detailed case study focusing on a specific site area during the project's seasonal drawdown will be assessed. You or your cultural resource coordinator should plan to attend. Second, a visit to areas where known historic properties are being affected will be attempted. Your District Archaeologist will be participating in this field visit.

3. The second round of field visits is scheduled for the period of July 31-August 11:

Bluestone Lake, Hinton, WV - 0900 on 1 August 1995

Allegheny Reservoir, Warren, PA - 0900 on 3 August 1995

Mansfield Hollow Lake, Mansfield Cent., CT - 0900 on 7 August 1995

Ball Mountain Lake, Jamaica, VT - 0900 on 9 August 1995

4. Your cooperation and assistance during the field visit will be greatly appreciated. Because I will be on official travel during the week of July 24-28 all questions you might have about the work unit and field visits should be directed to my supervisor, Mr. Roger Hamilton, Chief, Resource Analysis Branch, Environmental Laboratory, at 601/634-3724. Other questions concerning the field visits should be directed to your District Archaeologist.

Robert A. Dunn
Research Archaeologist
CEWES-EN-R

Figure 1. Memorandum describing 1995 field visits

1996 Return Field Visits to Three Reservoirs

In February and March of 1996, the authors of this report returned to three of the reservoirs to make detailed observations on the impacts to historic properties at these projects and to collect data for the preparation of the case studies that are included in this report. The projects revisited included Barren River Lake in Kentucky, Bluestone Lake in West Virginia, and Allegheny Reservoir in Pennsylvania and New York.

The data obtained by the WES team were also used to make detailed site protection recommendations to the District archaeologist or cultural resources coordinator. During its visit, the WES team inspected numerous National Register eligible historic properties at each project, not all of which have been discussed here. Excluding travel time, 3 days were spent in the field at each project. In addition to the extensive notes, sketches, and still photographs made by the team members, all the visits to the sites described in this report were videotaped.

Figure 2 illustrates the approach taken with these follow-up field visits. Dr. Lawson Smith prepared a geomorphic assessment for all of the major sites visited (Appendix A). Mr. Hollis Allen (bioengineering) and Mr. Hugh Taylor (geotechnical engineering) made detailed site protection recommendations based on their extensive experience in the field of erosion control.

MEMORANDUM FOR SEE DISTRIBUTION

DATE: 1/23/96

SUBJECT: Case Study Field Visits for Research Work Unit 32881 "Techniques for Effective Management of Historic Properties on Lakeshores and in Drawdown Zones"

1. The Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station (WES), is investigating impacts to archaeological sites which occur as a result of reservoir drawdowns. To aid Corps archaeologists in more effectively managing this class of cultural resources, HQ, USACE has provided funding to WES through the Corps' Environmental Impact Research Program (EIRP) to conduct a research program with the following goals:

- a. Better delineation of the problem, especially in terms of methods for improved impact assessment and the quantification of effects.
- b. Techniques for efficient identification and evaluation of historic properties (those eligible for the National Register of Historic Places) affected by drawdowns.
- c. Guidelines for the treatment of such properties, including monitoring, data recovery, and preservation options.

2. Based on the initial field visit to your project in 1995 and subsequent coordination with your District Archaeologist/Cultural Resource Coordinator your project is one of three which has been selected for more detailed study. The observations and data obtained by the WES team (listed below) will be used in the preparation of a site protection case study for the research work unit on drawdown impacts. During our visit the WES team will inspect one or more National Register eligible historic properties at your project, analyze geomorphic and human impacts to the site(s), and prepare detailed recommendations for its future management. The team's observations and recommendations will be submitted to your District Archaeologist and later incorporated in the second draft report for the research work unit. Excluding travel time three days are scheduled to be spent at each project.

3. The WES site protection team includes the following individuals:

Mr. Robert Dunn, Environmental Laboratory, Research Archaeologist and Principal Investigator

Dr. Lawson Smith, Geotechnical Laboratory, Senior Research Geomorphologist

Mr. Hollis Allen, Environmental Laboratory, Research Biologist

Mr. Hugh Taylor, Geotechnical Laboratory, Research Civil Engineer

4. The follow-up field visits are scheduled for the period of February 19 - March 15 as follows:

Barren River Lake, KY - meet at 0900 on 20 February 1996; on-site 20-22 February

Bluestone Lake, Hinton, WV - meet at 0900 on 5 March 1996; on-site 5-7 March

Allegheny Reservoir, Warren, PA - 0900 on 12 March 1996; on-site 12-14 March

You and your cultural resource coordinator should plan to attend the initial meeting on the first day of the field visit. Following that orientation meeting field inspection of the sites nominated by your District Archaeologist or Coordinator will be attempted. Your District Archaeologist will be participating in the meeting and the site inspection.

5. Your cooperation and assistance during the field visit will be greatly appreciated. All questions you might have about the work unit and case study field visits should be directed to me at 601/634-2380 or to my supervisor, Mr. Roger Hamilton, Chief, Resource Analysis Branch, Environmental Laboratory, at 601/634-3724. Other questions concerning the field visits should be directed to your District Archaeologist or Coordinator.

Robert A. Dunn
Research Archaeologist
CEWES-EN-R

cc:

Anne Bader (CEORL-PD-R)

Dr. Robert Maslowski (CEORH-PD-R)

Kathleen Anderson (CEORP-OR-R)

Figure 2. Memorandum describing 1996 follow-up field visits

3 Evaluating Archaeological Resources as Historic Properties

Site Evaluation Imperative

All archaeological sites do not meet the criteria of eligibility for the National Register of Historic Places. Those that do are "historic properties" as defined in ER 1130-2-438. Paragraph 4a of that regulation defines "Historic Properties" as any prehistoric or historic district, site, building, structure, or object included or eligible for inclusion in the National Register of Historic Places (NRHP).

One does not know if an archaeological site is a "Historic Property" without formal archaeological testing and evaluation of its significance against established criteria of eligibility and defined research objectives. Only in a few rare cases have archaeological sites been determined eligible for the National Register without this type of formal evaluation (e.g., based on surface indications of great antiquity).

The legal requirement to evaluate cultural resources for the National Register is clearly codified in Section 110(a)(2) of the National Historic Preservation Act (NHPA). However, within many Corps Districts, there still exists an erroneous unwritten policy that there must be a Section 106 "Federal undertaking" (e.g., construction project, permit) before funds are made available for the intensive site testing required by most State Historic Preservation Officers (SHPOs).

Since site testing is usually tied to an imminent construction project, the receipt of operation and maintenance (O&M) funding for testing/evaluation of archaeological sites in the drawdown zone is a rare occurrence in many Corps Districts. This is a distortion of the NHPA. Section 110, and not Section 106, is the applicable regulation for the inventory (recordation and evaluation) of sites in reservoir drawdown zones.

In most Corps Districts, only a small percentage of the total number of sites recorded in reservoir drawdown zones have been tested or formally evaluated for the National Register. This is confirmed by a review of the survey questionnaire data discussed in Dunn (1996:32-42). The data on site inventory submitted each year by the Corps Districts for the Secretary of Interior's report to Congress on Federal archaeological activities also confirms this. Upland fee lands under Corps ownership still contain many archaeological sites that have never been evaluated for their National Register eligibility. The consolidated response submitted by Headquarters, U.S. Army Corps of Engineers (HQUSACE), for Fiscal Year 1995 indicated that there were 55,976 known archaeological properties on Corps-managed land. The total number of known archaeological sites still unevaluated was 35,217.

The evaluation of archaeological sites as historic properties in reservoir drawdown zones is the key to their long-term preservation. Under existing Federal law and Corps regulation, only "historic properties" can receive the benefits of long-term management. However, to secure the funding and the manpower to perform site evaluation, Corps Districts must acknowledge and comply with the inventory requirements of Section 110 of the NHPA.

Funding requests for site evaluation in drawdown areas too often fall prey to the Corps annual budgeting procedure. As described in the Corps EC 11-2-166 (dated 31 March 1992), these are the funding levels of the annual O&M budget:

"Baseline. Annual costs to manage historical, archaeological and cultural resources activities, and perform historic property resource surveys and testing as required by law to enable accomplishment of other newly initiated and ongoing baseline activities include necessary coordination with other agencies, State Historic Preservation Offices (SHPO), and the Advisory Council on Historic Preservation (ACHP).

"Non-Deferrable in Budget Year. Non-annual costs which cannot be deferred to manage historical, archaeological, and cultural resource activities, and for initial historic property resources surveys and testing of identified sites including necessary coordination with other agencies, State Historical Preservation Offices (SHPO), and the Advisory Council on Historic Preservation (ACHP).

"Deferrable in Budget Year. Non-annual costs which can be deferred to manage historical, archaeological and cultural resources activities, and for initial historic property resource surveys and testing of identified sites including necessary coordination with other agencies, State Historical Preservation Offices (SHPO), and the Advisory Council on Historic Preservation (ACHP)."

To effectively manage sites in reservoir drawdown zones, each District must create baseline-level funding that can be counted on every year. Until every site is evaluated and the adverse effects to identified historic properties mitigated through data recovery and/or site stabilization, a baseline-funding

category for drawdown site evaluation must be part of the annual O&M budget.

Testing for National Register Eligibility

Section 110 of the NHPA requires Federal agencies to evaluate archaeological sites on lands under Federal control. But exactly how should this be done? Site evaluation guidance appears in the Section 110 guidelines that first appeared in the Federal Register at 53 FR 4727-46, 17 February 1988. Annotated Section 110 guidelines were jointly issued by the Advisory Council on Historic Preservation and the National Park Service in November 1989.

The Advisory Council's regulation on the implementation of Section 106 of the NHPA, 36 CFR 800, also provides helpful guidance on the coordination with SHPO that is required whenever a Federal agency evaluates the significance of archaeological sites. This coordination requirement for site evaluation applies equally to Section 106 "undertakings" and Section 110 inventory efforts.

Section 800.4(b) of the regulation requires Federal agencies to "in consultation with the State Historic Preservation Officer...make a reasonable and good faith effort to identify historic properties that may be affected by the undertaking and gather sufficient information to evaluate the eligibility of these properties for the National Register. Efforts to identify historic properties should follow the Secretary's "Standards and Guidelines for Archaeology and Historic Preservation" (48 FR 44716) and agency programs to meet the requirements of Section 110(a)(2) of the Act."

Section 800.4(c)(1) states that in evaluating historic significance, the Agency Official shall "in consultation with the State Historic Preservation Officer and following the Secretary's Standards and Guidelines for Evaluation, ... apply the National Register Criteria to properties that may be affected by the undertaking and that have not been previously evaluated for National Register eligibility." It is important to note that when the Agency (e.g., the Corps District) and SHPO agree that the site is eligible for the National Register under criteria set forth in 36 CFR 60.4, the property shall be considered eligible for the National Register.

Archaeological sites are usually evaluated under criteria D to determine if they "have yielded or may be likely to yield information important in prehistory or history." How then can an agreement be reached in the most efficient and cost-effective manner? For archaeological sites in drawdown zones, which are the primary focus of this study, the answer in most cases is through Phase 2 testing.

Phase 2 testing typically involves a spatially controlled surface collection of artifacts and the excavation of sample quadrats, or test units, with strict

vertical and horizontal control of artifact and feature provenience. Dancey (1981:128-150) provides a useful discussion of standard methodologies employed in archaeological testing. In recent years, pinpointing the location of a site with a global positioning system (GPS) for later use in a geographical information system (GIS) is becoming a standard operating procedure during testing. In general, archaeological testing provides critical information concerning the integrity of the cultural deposit(s), its age and possible cultural affiliation, as well as information on the horizontal and vertical extent of the site.

The size and number of test units required for Phase 2 testing may vary from State to State. Specific requirements for Phase 2 testing are usually discussed in the State's Plan for the Conservation of Archeological Resources. One midwestern SHPO required only one test unit of 1 m² in horizontal extent to make a judgment on site eligibility. Other SHPOs may require more test units, larger units, or even the excavation of backhoe trenches. Some enlightened SHPOs may wish to incorporate mechanized coring (e.g., such as the chain-driven Bull corers used by the Soil Conservation Service for soils mapping) or hand coring with augers, silt probes, or post-hole diggers in addition to the primary test excavation unit(s) when the primary issue is determining the horizontal extent of a cultural deposit. The importance of Phase 2 testing is that it gives the Federal agency and the SHPO some rational basis for a critical decision on whether a site warrants long-term management.

This vital procedure has only rarely been combined with the initial site recordation process at many Corps reservoirs. This became evident in the course of the 1995 field visits to nine Corps of Engineers (COE) reservoirs (Dunn 1996:46-63). It is also reflected in the Districts' responses to the survey questionnaire.

One recommended management technique for intensive archaeological surveys of reservoir drawdown zones is to perform Phase 1 (initial site recordation) concurrently with Phase 2 (site evaluation). This allows for the maximum amount of work while the reservoir is drawn down. It is important, however, to allow for SHPO review of the proposed combined survey/testing methodology prior to the onset of fieldwork. This combining of Phases 1 and 2 will also require greater up-front planning in order to pinpoint areas with the best potential to contain intact cultural deposits. From a budgetary perspective, the greater cost of these projects may also require greater lead time.

Because of the severe erosion that archaeological sites experience in reservoir fluctuation zones, a different approach to significance evaluation may also be required. Multicomponent sites may have upper levels with compromised integrity but intact lower components. Site testing should concentrate on identifying whether there are sealed intact components that may still satisfy National Register criteria D (archaeological research potential). Such sites may still be determined eligible for inclusion in the National Register. Buried and intact components of archaeological sites with disturbed upper strata may still be deserving of data recovery or site protection.

Remote Sensing and Site Significance

Conventional Phase 2 site testing has an important role in site evaluation, but it is not an exclusive role. Briuer argues forcefully that site evaluation can also benefit from the use of new technologies such as GIS and geophysical remote sensing:¹

“The science of grappling with archaeological significance, explaining of cultural patterning etc., resourcefully and parsimoniously wringing out every bit of useful and relevant information available, particularly in a regional framework and independent of geomorphological science, is a no less demanding and equally important enterprise. The science of significance evaluation is fluid and dynamic also.”

Briuer (1994) and his WES colleagues used a variety of geophysical techniques in a survey and testing project for the U.S. Coast Guard Maintenance and Logistics Command Atlantic at the former U.S. Coast Guard Station in Gloucester, NJ. These methods included ground penetrating radar, magnetic survey, and continuous wave electromagnetics. A brief description of each method appears below. This will be followed by a discussion of their utility for the evaluation of archaeological sites.

Ground penetrating radar (GPR)

“Ground penetrating radar is a geophysical subsurface exploration technique using pulsed high frequency electromagnetic waves. The GPR system consists of a pulse signal generator, transmitting and receiving antennas, signal conditioner, and visual output devices. The transmitting antenna provides an electromagnetic pulse which propagates into the ground. This signal becomes absorbed, scattered, and/or reflected depending upon the contrast in dielectric properties of the subsurface media. Lastly, the altered electromagnetic pulse is detected by the receiving antenna. These signals are then amplified, processed, and displayed to provide a continuous profile of the subsurface. The transmitted EM pulses are altered by changes in the subsurface soil electrical property conditions. These may be due to changes in clay content, soil moisture, water salinity, man-made objects, etc. The larger the contrast in electrical properties of adjacent materials, generally the greater is the amount of reflected EM energy and the easier the resolution of the condition. The depth of exploration at a particular site is governed by the electrical properties of the soil and the characteristics of the transmitting and receiving antenna” (Briuer 1994:6-2).

¹ Personal Communication, 1995, Dr. Fredrick L. Briuer, archaeologist, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

For the application at the former Coast Guard facility in Gloucester, NJ, a GSSI SIR System 8 radar with a 300-MHz antenna was used in the investigation of the project area.

Magnetic survey

“Geomagnetic surveys measure the total magnetic field intensity horizontally over the ground surface. These surveys are generally conducted over a surveyed grid at the area of interest with measurements collected in a systematic fashion. The magnetic method is based on the ability to measure local disturbances in the earth’s magnetic field. Materials with remnant magnetization or a high magnetic susceptibility have a tendency to interact and/or alter the intensity of the earth’s magnetic field. Depending upon these properties and the size, shape, and distance to the object, these local magnetic field changes may be great or small and extend for a few inches to tens of feet. Prehistoric magnetic anomalies include hearths and other burn features such as locations where pottery was fired. The increased temperature at the pit induces a small amount of remnant magnetization which typically will produce a local magnetic anomaly of a few nanoteslas (nT). Historical objects such as pipes, storage drums, reinforcement bars, and other steel and iron objects of any purpose produce local magnetic variations of tens to hundreds of nanoteslas in the earth’s magnetic field. In addition, fired brick has a substantial remnant magnetization and generally produces a large magnetic anomaly” (Briuer 1994:6-3).

The instrument used in the Gloucester study was an EDA OMNI IV proton-precession magnetometer. The total magnetic field was collected at the corners of a 5- by 5-m grid. The magnetometer used in this survey has an absolute accuracy of ± 1 nT, with a repeatability of ± 0.2 nT.

Continuous wave electromagnetics

“The electromagnetic technique is used to measure changes in subsurface electrical conductivity. These changes are due to material type (clay, silts, sands, etc.), soil moisture, chemical makeup, and other physical properties... An alternating current enters a transmitter coil producing a primary magnetic field. This oscillating field intersects with conductive material in the subsurface, thus generating eddy currents. These electrical fields generate secondary magnetic fields which are received, along with the primary field, at a receiver coil. The amplitude and phase shifts of the received signal are used to determine the conductivity of a predetermined volume in the subsurface. The depth of investigation is a function of the transmitter receiver geometry, the broadcast frequency, and the separation distance of the transmitter and receiver coils. The units of conductivity are millimhos (mmho/m) or in the SI system, milliSiemens per meter (mS/m). As in the magnetic surveys the data are collected at the corners of grid squares...and the resulting measurements

are contoured to produce a figure displaying spatial changes of spatial conductivity" (Briuer 1994:6-4).

Discussion

The geophysical methods described above can be an efficient and cost-effective way to determine the presence of buried archaeological features on sites with few or highly disturbed surface cultural material. If the locations of subsurface features (such as hearths, shell middens, burials, storage pits, etc.) can be pinpointed with such methods, Phase 2 testing can be focused in these areas. Test excavations or coring can determine more precisely the nature of the anomaly. Such data can be used by the Federal resource manager and the SHPO in making a determination of eligibility. In some cases, geophysical methods may be used in lieu of test units completely.

One site evaluation project incorporating GPR occurred in Wisconsin in 1983. This project involved the mapping with GPR of an extensive shell midden in a Corps Public Use area adjacent to the Mississippi River. The large midden was located about 5 m below the present ground surface. While coring revealed the presence of artifacts in association with the shell, the actual dimensions of the midden were determined through the use of GPR. Because the planned construction at this location would impact the upper portion of the cultural deposit, data recovery was subsequently conducted and GPR was used to locate the excavation units.

In the WES project at the former Coast Guard facility in Gloucester, NJ, the application of the three types of geophysical survey enabled Briuer (1994:6-11) to determine the following:

- a. Areas of unmapped utilities that could be avoided.
- b. Sections of the project area with extensive historic alteration.
- c. Those locations within the facility that had not been significantly altered and would thus have a greater probability of containing less disturbed prehistoric material.

Renfrew and Bahn (1991:80-80) present an overview of remote sensing techniques for detecting subsurface archaeological features. In addition to those discussed above, they include seismic and acoustic methods, radioactivity and neutron scattering, thermal prospection, and geochemical analysis. All of these techniques have particular applications and may not be suited for all sites.

Use of GIS in Assessing Significance

WES is now actively engaged in a multiyear research program sponsored by HQUSACE on the development of objective standards for assessing archaeological site significance. Funded through the Evaluation of Environmental Investments Research Program (EEIRP), this work unit, with Dr. Fred Briuer as Principal Investigator, includes the research of National Research Council Post-Doctoral Fellow Dr. Clay Mathers. An important component of their work is the demonstration of how the combination of GIS and predictive modeling can provide for the broader, more rapid, and more efficient evaluation of archaeological sites and their significance (Briuer and Mathers 1996).

A recent application of this research was made in the development of a GIS database for historic archaeological sites at Fort Leonard Wood, Missouri (Bennett et al. 1996). This real life example can illustrate the way in which geographic information systems may be used to assist in evaluating archaeological significance.

In the introduction to that report, Dunn, Mathers, and Briuer (1996:4) noted that traditional determinations of archaeological significance are often undertaken on the basis of site-by-site evaluations with a set of implicit assumptions and unstated criteria that go beyond the guidelines set forth in 36 CFR 60. This makes it difficult to evaluate cultural patterns at a scale larger than a single site. By focusing on individual sites rather than landscapes or larger groupings of sites, traditional site evaluation approaches have overlooked many aspects of regional context that bear on attributions of significance. Important sources of variability and patterning are masked that should be considered when managing a regional resource base such as a Corps District's archaeological inventory.

An important aspect of the "significance work" is that it clearly demonstrates the changeable and dynamic nature of archaeological significance. Of the numerous significance concepts identified in the worldwide archaeological literature, Mathers has identified the idea of "representativeness" as perhaps the most valuable and operational one. He argues that "while it would be a mistake to think of any single concept as a convenient, all embracing variable capable of summarizing all of the complexity surrounding the issue of archaeological significance, the idea of representativeness appears to come closest to this objective (Dunn, Mathers, and Briuer 1996:8)."

According to Mathers, the concept of "representativeness" implies the preservation of a suite of cultural resource types that represent the whole of activities associated with a specific chronological period, geographic area, and cultural group. To actually operationalize the concept, it is important to consider two types of information:

- a. Representative samples of cultural behavior of all types.
- b. Spatial phenomena (e.g., topographic and ecological variability).

In this context, a GIS becomes much more than an especially convenient mapping tool. It can be used to evaluate any entity or phenomena that can be assigned a set of spatial coordinates. It can be used to select the most representative and therefore most "significant" sample of sites for future management.

Using themes/contexts previously identified in a historic overview (Smith 1993) for the Fort Leonard Wood Army Garrison, Mathers and his colleagues showed how a newly created GIS database could be used for evaluating classes of historic archaeological sites (property types) against each of the major historic themes identified for the installation. The following example shows how this approach can be used for evaluating archaeological site significance against an identified historic theme.

"Upland South/Ozark (Settlement Patterns) ...Attribute data from the GIS database could be used, for example, to define important significance variables such as site chronology, function, data abundance, and spatial location. Important aspects of archaeological significance could then be evaluated by using these criteria to determine the uniqueness of sites and grouping of sites. Once this task was accomplished, it would be possible to examine the spatial dimension of these characteristics to determine, for example, if the sites with the earliest dates, most continuous occupations, and best documentary records all occurred in the same geographic area. Another, more robust avenue for analysis might be the search for repeated cells or clusters of sites representing groups and activities which were closely related (e.g., major pockets of arable land with a wealthy landowner and his tenant farms, large churches and schools, farms and special purpose industrial sites, etc.). Identification of such clusters would make a major contribution towards defining representativeness at a regional scale" (Dunn, Mathers, and Briuer 1996:15).

4 Assessing Impacts to Historic Properties

Applying the Criteria of Effect

Operational reservoir drawdowns are “Federal undertakings” subject to the consultation requirements of Section 106 of the NHPA, as codified in 36 CFR 800. Nevertheless, the cyclic inundation and exposure of archaeological sites have more often not been regarded by Corps Districts as a “Federal undertaking.” As argued in Dunn (1996), it is time that this erroneous interpretation of the NHPA be discarded.

Section 800.5(a) requires the Federal Agency Official to consult with SHPOs in applying the criteria of effect (Section 800.9(a)) to historic properties that may be affected, giving consideration to the views, if any, of interested persons (e.g., Native American tribes). Subsequent subsections of the regulation deal with the procedures to be followed for determinations of no effect, no adverse effect, and adverse effect. For purposes here, it is important to note that any time a historic property will be affected, the Advisory Council must be contacted and documentation provided for Council’s review and comment.

Dunn (1996) documented that reservoir pool fluctuations affect the archaeological sites within the reservoir drawdown zone. It is the responsibility of the Federal agency (e.g., the Corps District) to apply the criteria of effect to determine if that effect is an adverse one. In the next two sections, the discussion will focus on assessing the natural (geomorphic) and human impacts to historic properties in reservoir drawdown zones.

Geomorphic Assessment of Impacts to Historic Properties

A critical first step in applying the criteria of effect to archaeological sites in drawdown zones is to determine with the greatest possible precision how they are being (or may be) affected by the geomorphic processes at work

there. Such processes can be identified in an analytical geomorphic model of the reservoir. Three specific examples of this approach will be presented in the case studies discussed in a later section of this report. At this point, some general comments on this approach are in order.

In Dunn (1996:12), it was noted that “to effectively plan for future archaeological site protection or data recovery it is essential to know how the fluvial system operates and when and how the cultural deposits within that system will be affected.” If reservoirs are highly modified fluvial systems, they can be understood as a system. They are susceptible to geomorphic analysis. Where and when erosion and sedimentation may take place in an artificial reservoir can be anticipated just as with a natural fluvial system. In practical terms, erosion problems can be anticipated and plans made ahead for the mitigation of adverse effects to the cultural deposits contained within the fluctuation zone of that reservoir.

Smith and his colleagues at WES (Corcoran, Smith, and Nickens 1996) have in recent years begun to develop analytical geomorphic models for studying site erosion problems at Corps reservoirs in the Pacific Northwest. Specific types of erosion (e.g., mass failures, wave attack producing toe collapse) are identified and an assessment made on their potential effect to known sites or to landforms with the potential to contain buried cultural deposits. An estimate can be made on the rate at which this erosion will occur. The result of this work is lead time for the resource manager to develop a mitigation strategy that may include site protection and/or data recovery.

WES researchers are now preparing cultural resources monitoring and protection plans using these complex geomorphic models at several Corps reservoirs in the North Pacific Division. Such models make great use of modern GIS. A GIS database incorporating information on soil types, landforms, the erosion potential of these landforms, the location of known archaeological sites, the potential for buried archaeological sites within these landforms, and other pertinent data layers can move CRM into the 21st century and ensure that a representative sample of these sites be preserved for the future.

Geomorphic impacts on cultural resources in reservoir areas

The various geomorphic processes of erosion and deposition may have profound impacts on the cultural resources in the areas in which these processes are active. The occurrence of geomorphic processes is a product of the interaction of environmental conditions and processes. A large number of site factors influence the occurrence of geomorphic processes at any location. However, the local geologic, soils, topographic, vegetative, climatologic, and hydrologic conditions are the principal factors that must be considered in identifying, analyzing, and managing these potentially devastating phenomena.

In the identification, analysis, and management of the geomorphic processes that may impact cultural resources, it is important to recognize all of the processes that may occur, not simply areas of erosion and areas of deposition. Field examination of erosion processes in the three reservoirs indicates that at least five separate processes are active, each with different types of impacts, controlled by different factors, and requiring different management approaches. Similarly, at least three major types of depositional processes are active in reservoirs.

Development of monitoring and protection plans for cultural resources should be based on the understanding of the distribution and characteristics of the geomorphic processes that may impact the resources. The primary goal of the geomorphic investigations of the case study areas was to provide the geomorphic information critical to the development of monitoring and protection programs for cultural resources in the reservoirs' impact areas.

Factors influencing geomorphic impacts

The occurrence of geomorphic processes is a product of the interaction of environmental conditions and processes and are responsible for the preservation or destruction of cultural resources. Various factors affect the rate and degree of the geomorphic impacts. The geology is essential in analyzing parent material, type of fill material, and engineering properties. Soil is of interest in determining the moisture content, mineral stability, structure, and permeability. Climate may affect soil and geologic properties. Any changes in local climate that increase the humidity accelerates the rate of decay of exposed cultural resources. On the other hand, a change to a drier climate will aid in preservation of resources. Any variation in climate due to elevation or exposure to weathering can cause significant differences in geomorphic processes. Topography or relief of an area will decrease or increase geological processes. The type of failure along the valley walls of the river are directly related to elevation. For instance, the impact of wave action is only visible at a lower elevation. At higher elevations, any ponding of water, whether man-made or natural, will affect the rate of geomorphic impacts. Geologic structure, such as bedding and faults, may impede movement of subsurface water as well as restrict development of a vegetative root system. The type and amount of vegetation and extension of the root system may alter the stability of the surface. Human activities have also been apparent in both impact zones. Campgrounds and recreation sites have sometimes been constructed over archaeological sites. Human influences, including steepening of the slopes through excavation, water diversion onto the slopes, and the placing of fill on the slopes, affect both the spatial and temporal distribution of mass movement.

Impacts of erosional processes

Erosion, usually resulting from fluvial degradation or excessive precipitation in this area, is a continuous process and may destroy or alter archaeological sites. Even if resources are not destroyed, exposure of archaeological sites increases illegal artifact collection. Reservoirs create a unique erosional situation in that their impoundments create erosional shores on slopes previously unaffected by lacustrine processes, causing immediate and accelerated erosion and sedimentation. Bank erosion results in the loss of vegetation that serves as a protective cover over soil and sediment.

Although numerous factors influence the rate and occurrence of erosion, the primary cause of bank erosion is wave action. In the three reservoirs investigated, wave action was found to be the dominant process not only in occurrence but in extent of destruction as well. Wave action can be generated from wind, tectonism, and pool-level fluctuation. Erodibility index of the soil and the slope of the surface also need to be considered. Erosion exists in both zones of impact although reservoir fluctuations do not directly affect erosional processes or depositional processes of the indirect impact zone.

Surficial geomorphic processes include mass wasting of soil and rock from slopes, overland flow of runoff as "sheetwash" on hillslopes and other sloped surfaces, concentrated water flow in channels of gullies and small streams, wave attack along reservoir shorelines, and dispersion of saturated soil. In part, bank stability varies with fluctuation levels. Mass wasting is produced by various processes, including fluvial and aeolian, and results in downward movement of surficial material. Sites may be buried if the site is located at the base of the failure or may be completely destroyed if the site is located along the slope. As material is moved to a lower elevation, the stratigraphic record and environmental context of the archaeological record is altered. Locations of sites on the landscape may also be altered by mass wasting. Forest practices, especially those associated with timber harvest and road construction, have increased mass wasting on already unstable slopes. Overland flow occurs on hillsides during a rainstorm when the soil moisture storage capacity is exceeded (in the case of prolonged rain) or with intense rain, the infiltration rate of the soil is less than the precipitation rate. Soil loss from sheetwash varies according to velocity and turbulence of the flow and is more prevalent in areas with little or no vegetation. Gully erosion is another major geomorphic process affecting archaeological sites. Gullies are steep-sided stream courses that experience ephemeral flows during rainstorms. The width and depth of the gullies are highly variable and are a function of soil, topographic, and vegetative cover characteristics.

Impacts of depositional processes

The degree and type of deposition over an archaeological site will determine preservation or degradation of cultural resources. In most instances, deposition of sediment will aid in preservation of the archaeological record by

forming a barrier between sites and destructive processes. Unfortunately, sedimentation may also shield sites from shallow investigations and destroy fragile cultural resources. An understanding of sedimentation rate and sediment type and amount is important in evaluation of site preservation. Three general types of deposition that occur in reservoirs are colluviation of mass wasting and soil dispersion deposits at the base of the slopes, fluvial deposition of sediments from sheetwash and channels, and lacustrine deposition of wave-eroded materials. Although deposition is an important process, erosion is more prevalent nearshore. Depositional processes occur in the nearshore zone as well as in deeper waters.

Human Impacts to Historic Properties

Archaeological sites in reservoir drawdown zones are most often adversely affected by a combination of geomorphic and human impacts. Sites initially exposed by erosion become targets for illegal excavation or "pothunting," which causes even greater erosion and in the worst cases total site destruction. In the course of the 1995 field visits to nine Corps reservoirs, one of the authors observed that when historic properties had been allowed to substantially deteriorate, illegal surface collection and excavation increased. It is useful at this point to briefly review the regulations pertaining to human impacts to historic properties.

Section 110 (a)(2) of the National Historic Preservation Act of 1966, as amended, requires that "each Federal agency shall exercise caution to assure that any such property that might qualify for inclusion (in the National Register of Historic Places) is not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate significantly." To allow surface collection or unpermitted excavation of historic properties is clearly a violation of this statute.

Corps regulation ER 1130-2-438 (PROJECT CONSTRUCTION AND OPERATION—HISTORIC PRESERVATION PROGRAM) notes the following in Section 19a (Enforcement under 36 CFR 327, Title 36).

"...This is the only authority available to Corps of Engineers personnel for the protection of historic properties. Since the value of historic properties and associated costs resulting from unauthorized activities usually exceeds the maximum fine under Title 36, the enforcement actions necessary to investigate, prepare cases, and apprehend violators may be more appropriately handled by others under provisions of the Archeological Resources Protection Act."

and in Section 19b:

"The Archeological Resources Protection Act of 1979 (ARPA) provides for criminal penalties up to \$100,000 and/or two years imprisonment, and allows for forfeiture to the Federal government of equipment and vehicles used in

unauthorized activities. In addition, civil penalties may be assessed to recover federal costs in repairing or restoring historic properties, accomplishing research and preparing reports. Since there is no enforcement authority under ARPA for Corps of Engineers park managers, rangers, archaeologists, or other staff, District Commanders shall follow procedures outlined in ER 1901-50 to obtain services of the Criminal Investigation Command (CID) for such investigations, Commanders may also obtain services of the appropriate U.S. Marshal for immediate attention to suspected or known felony acts.”

36 CFR 800.9(b) describes the criteria of adverse effect in the following manner:

“An undertaking is considered to have an adverse effect when the effect on a historic property may diminish the integrity of the property’s location, design, setting, materials, workmanship, feeling, or association. Adverse effects on historic properties include but are not limited to:

- (1) Physical destruction, damage, or alteration of or part of the property;
- (2) Isolation of the property from or alteration of the character of the property’s setting when that character contributes to the property’s qualification for the National Register;
- (3) Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;
- (4) Neglect of a property resulting in its deterioration or destruction; and
- (5) Transfer, lease or sale of the property.”

The practical import of these laws and regulations for the resource manager is that the vandalism of historic properties, even in drawdown zones, is unquestionably an “adverse effect.” The Corps is required to prevent such activity and to mitigate this adverse effect when it has reached the point where the integrity of the site begins to be compromised. Specific recommendations for combating the vandalism problem and descriptions of successful mitigation strategies are presented in a later section of this report.

5 Mitigating Adverse Effect

Data Recovery and Site Protection

The National Reservoir Inundation Study, conducted in the late 1970s, concluded that, "in the majority of cases, data recovery was the most viable alternative for sites in a reservoir's fluctuation zone" (Lenihan et al. 1981). Dancey (1981) and Renfrew and Bahn (1991) provide useful discussions of archaeological excavation techniques used in data recovery projects. The focus here will be on determining when data recovery or site protection is most appropriate.

After 20 years of research on site protection, the question whether data recovery or site protection is the better long-term management option simply depends on individual site conditions. Dunn (1996:28) discusses the "site-decay matrix" developed at Texas A&M University by Mathewson (1989) and argues that the analysis of site environmental conditions is a prerequisite for the design of a site protection plan. Actually, the analysis of environmental site conditions is necessary to decide whether site protection, rather than data recovery, is even feasible.

Following the completion of the field work for the case studies described in this report, it now appears that the combination of limited data recovery and site protection may be the best course of action for most affected historic properties in drawdown zones. It is the unusual case where only data recovery or only site protection can be used.

One reason for this is that the implementation of many site protection methods requires some earth disturbance. This can impact the site to such an extent that data recovery of that secondary impact area will be required by SHPO as mitigation. This was the case in the protection of the Greer Mound site along the Arkansas River (Dunn 1991).

Another reason is that most data recovery research designs prescribe a sample percentage rather than complete excavation of the cultural deposit. The size of the sample will vary with the size and the nature of the site and is usually negotiated with SHPO and the Advisory Council on Historic Preservation. Protection of the remaining cultural deposit should always be carefully

considered for future research efforts if it can be done in a cost-effective manner (e.g., site burial or use of a vegetative cover).

Identifying Technologies for Site Protection

The results of a literature search on previous WES site protection research were presented in Dunn (1996:20-29). In this report, emphasis shifts to more specific technical information that can be readily adapted to real-world site protection challenges. It is beyond the scope of this report to present detailed descriptions of every new technological innovation in erosion control. It is very appropriate, however, to point out important sources of information that interface this rapidly expanding technology with the concerns of cultural resource managers.

Dr. Robert Thorne, Director of the National Clearinghouse for Archeological Site Stabilization at the University of Mississippi, has provided cultural resource managers with several monographs on archaeological site stabilization techniques and how they can be adapted to particular site conditions (e.g., Thorne 1988). Thorne (1991) provides a comprehensive listing of sources of technical information to support archaeological site stabilization projects.

Thorne (1995) is a comprehensive annotated bibliography on "In-Place Archaeological Conservation and Stabilization." This bibliography is divided into four sections that are intended to support the conceptualization, design and development, and implementation of archaeological site stabilization and preservation projects. The first section provides a philosophical overview for site preservation and stabilization, emphasizing the justification of archaeological site stabilization projects. The second section emphasizes technical support. It draws together a body of technical literature generally unknown to archaeologists. This technical information is critical for the successful design of stabilization projects. Section 3 focuses on management recommendations. It contains a mix of projects for which site stabilization was not considered the best choice, but stabilization efforts were finally selected as the best mitigation approach. Section 4, on practical applications, presents a series of case histories. Thorne (1995:3) notes that the data contained in the bibliography will provide an insight into the planning and implementation of stabilization projects already in place and serve as a partial base for the development of new projects.

The technical notes of the Archeological Sites Protection and Preservation Notebook (ASPPN) first produced by WES in 1992 are a valuable source of information on site protection methods. The notebook is organized by protection categories such as the following:

I-Impacts, II-Site Burial, III-Structural Stabilization, IV-Soil and Rock Stabilization, V-Vegetative Stabilization, VI-Camouflage and Diversionary

Tactics, VII-Site Surveillance, VIII-Stabilization of Existing Structures, IX-Faunal and Floral Control, X-Signs, XI-Inundation.

Shown below is the interface of Shields' (1991) research on appropriate engineering techniques for site protection with the ASPPN categories. The Roman numerals refer to ASPPN technical notes that provide specific examples. For example, III-4 would be technical note number 4 within protection category III (Structural Stabilization):

Indirect Protection

Grade Control Structures

Weirs

Modification of Flow Alignment

Transverse (spur) dikes

permeable (board fences, Kellner jacks, etc.)

impermeable (stone) - III-4 (gabion groins)

Parallel Dikes (Retards)

permeable (board fences, Kellner jacks, etc.)

impermeable (stone) - III-4 (rock-filled log cribs)

Vanes

Removal of large woody debris

Flow Diversions and Slope Drains

Direct Protection

Monolithic Cover (concrete, asphalt, grouted riprap)

II-2 (gunite)

Granular Cover (gravel, riprap, soil cement blocks,

rubble, etc.) - III-2, III-4, III-4 (riprap); III-9

(Filter cloth and riprap); III-10 (rubble)

Windrow or trenchfill

Matting Cover (fabrics, gabions, auto tires, lumber

mattress, etc.) - III-5 (logs)

Bulkhead - III-1 (gabion), III-3 (sheet piling), I-17

(wood), V-2 (timbercrib with vegetation)

Vegetation - V-2 (Woody vegetation with floating

breakwater), V-1, IX-2

Clay Blanket

Soil Stabilization

Slope Stabilization

Excavation to reduce bank height or angle

Subsurface Drainage

Retaining wall (bulkhead) III-1 (gabions)

The technical journal *Erosion Control*, published bimonthly by The International Erosion Control Association (IECA), is an excellent source of up-to-date information on emerging technologies in the field of erosion control. Information on geotextile cellular confinement systems, hydroseeding, erosion

control fabrics, anchor wall systems, earth anchor systems, silt fences, erosion control matting, gabion walls and mattresses, articulated concrete blocks, articulated cable concrete mat systems, geotubes and geocontainers for dredged material, retaining walls, biodegradable blankets, and a host of other new approaches are discussed in every issue. The Proceedings of the IECA issued for their annual meetings is also an excellent information source on the latest advances in the field. Specific applications of some of these erosion control technologies are presented in the case studies section of this report.

The interdisciplinary nature of site protection projects may be already evident to the reader. The interdisciplinary team approach taken in the case studies presented in this report proved essential, both in analyzing the impacts to historic properties, and in developing recommendations for their short- and long-term protection. In this regard, Mathewson (1989:233) made this observation on the interdisciplinary nature of site protection projects:

“Once the site components have been defined and the desired environmental conditions for preservation defined, the engineers and scientists must evaluate the site to determine the existing physical, biological, and chemical conditions. Design concepts are then developed and evaluated to determine if the desired environmental change will occur. If the desired conditions can be generated, then the design concept is evaluated with respect to the cost of the proposed burial project. If the design is economically favorable and the environmental change will enhance site preservation, then the project can be implemented.”

6 Long-Term Management Issues

Cultural Resources Monitoring Plans

Dunn (1996:65-66) provides a summary description and justification for the development of Cultural Resources Monitoring Plans (CRMP). The overall purpose of the CRMP is to determine how archaeological sites and other traditional cultural properties at a reservoir are being (or may be) affected by the geomorphic processes and present human use of the reservoir and to plan effective countermeasures.

Development of a detailed CRMP is an essential step in preventing site destruction and the loss of scientific data. A CRMP integrated with an analytical geomorphic model provides the resource manager with the conceptual tools and the baseline data on site condition needed for best practice cultural resource management. When the CRMP and the geomorphic model is contained within a computerized GIS, the opportunity for truly effective management can be actualized.

The GIS recently developed by WES researchers for Dworshak Reservoir in Idaho will enable those resource managers to more efficiently determine the effects of geomorphic and human processes to cultural resources:

“... a geographic information system allows input, storage, and manipulation, and analysis of spatially referenced data. The major analysis techniques will be the combination or linkage of data layers to analyze or display spatial queries... a GIS can answer questions involving location, condition, trends, patterns, and modeling. Although a GIS is not simply a database for constructing maps, it can create maps at different projections, scales, and colors” (Corcoran 1995:ii).

In the monitoring plans now being developed at WES (Corcoran, Smith, and Nickens 1996), all available site data are first critically evaluated to determine the archaeological significance of known sites and their distribution across the landscape. The potential of landforms within the project area to contain unrecorded but potentially significant cultural deposits is also assessed

using a previously developed analytical geomorphic model. A Conceptual Model for Site Impacts from geomorphic and anthropogenic impacts is then created and incorporated into a GIS database.

A site monitoring program can then be designed that will set forth guidelines and methods/technologies and identify additional inventory and evaluation needs. The monitoring program is refined following an initial pilot study and thereafter modified by the periodic re-examination of site impact data.

This conceptual approach for CRMPs was used by WES researchers for Walla Walla District's Dworshak Reservoir, Idaho (Corcoran, Smith, and Nickens 1996). The details of the approach are summarized in the following tasks:

Task 1 Evaluate Available Archaeological Data

- Bibliography of Previous Research
- Review Archaeological Site Files
- Review Site Distribution Maps/Aerial Photos
- Assess Physical Environment
- Describe Past Cultural Environment
- Describe Present Human Use

Task 2 Develop Conceptual Model

- Identify Monitoring Needs

Task 3 Database

- Analyze Inventory Data
- Data Integration (GIS)

Task 4 Design Monitoring Program

- Identify Objectives and Monitoring Priorities
- Develop Monitoring Guidelines/Attributes to be Monitored
- Prescribe Methods/Technologies
- Identify Additional Inventory Needs

Task 5 Analysis and Synthesis

- Analyze and Synthesize Data
- Create Predictive Models
- Prepare Management Recommendations
- Report Findings
- Identify New Needs, Threats, and Concerns

Historic Properties Management Plans

At the present time, Corps Districts vary widely in their compliance with the requirement of ER 1130-2-438 to develop Historic Properties Management Plans. This is clearly reflected in the results of the survey questionnaire

discussed on drawdown zone impacts in Dunn (1996:37). Some Corps Districts are close to full compliance with the regulation. Others, particularly those with numerous reservoirs, may have only a few HPMPs completed. One of the conclusions of the first technical report was that even when an HPMP had been prepared for a reservoir, there was a general lack of emphasis on the preparation of subsections within the HPMP that dealt specifically with the drawdown zone problem. It is imperative that HPMPs include a protection plan for the historic properties contained in the reservoir's drawdown zone.

A Drawdown Zone Protection Plan (DZPP) would have as its primary purpose the prevention or mitigation of adverse impacts to significant cultural resources in the drawdown zone that meet the criteria of eligibility for the National Register of Historic Places. In cases where site protection is not feasible, a program of data recovery through scientific archaeological excavation may be recommended.

A first element of the DZPP would be to determine which sites are significant and therefore require long-term management and protection. Typically, many sites in reservoir drawdown zones have not been formally evaluated for the National Register, and testing through sample archaeological excavation may be required to make this determination in coordination with the State Historic Preservation Officer. Detailed recommendations for site testing could be made in the DZPP. Another element of such a plan would be to conduct site protection assessments of the significant sites identifying the kinds of impacts and their immediacy. In cases where protection of the site is technically feasible, suitable protection approaches and technologies should be clearly identified. Finally, the DZPP should contain recommendations for site protection project design for each significant site and describe subsequent monitoring and maintenance needs.

The conceptual approach shown in the tasks listed below closely follows the one developed by WES for Walla Walla District at Dworshak Reservoir, Idaho (Corcoran, Smith, and Nickens 1996).

Task 1 Evaluate Database

- National Register Eligibility
- Likelihood of Resource Loss

Task 2 Conduct Site Protection Assessments

- Archaeological Content
- Condition
- Identify Kinds of Impacts and Their Immediacy

Task 3 Determine Appropriate Mitigation Approach

- Determine Which Sites Can Be Protected
- Identify Protection Objectives, Priorities, and Requirements
- Identify Potential Protection Approaches/Technologies

Task 4 Implement Site Protection

Develop Protection Project Design

Install Site Protection Technology

Prepare Report on Site Protection Effort

Identify Monitoring and Maintenance Needs

7 Vandalism Problem

Enforcement of ARPA and Title 36

There is currently within the Corps of Engineers both a lack of trained personnel and a lack of procedural guidance on law enforcement options to effectively enforce ARPA and Title 36 in reservoir drawdown zones (Dunn 1996:46-63). During the course of nine field visits, this point was driven home to the authors time and again. The following excerpts from the 1995 field observations illustrate the variety of law enforcement problems that are encountered at the field level.

Grenada Lake (Mississippi)

Ranger patrols are occasionally undertaken to deter surface collectors, but there are no ARPA prosecutions or citations under Title 36 on record at the project office. There is reported damage to sites from the use of all-terrain vehicles used on the exposed mud flats during drawdowns. There is no record of coordination with the Mississippi SHPO on impacts to sites in the drawdown zone.

Wright Patman Lake (Texas)

There have been several ARPA prosecutions and a number of Title 36 citations issued to individuals to halt the vandalism of these sites. While the Texas SHPO is aware of the pothunting problem at Wright Patman, there is no individual coordination of site impacts by District personnel. The cultural resource coordinator for Wright Patman has, on his own initiative, installed electronic intrusion detection devices on several Caddo burial sites that have become the targets of pothunters.

Eufala Lake (Oklahoma)

With only two rangers for this enormous project and no baseline funding for work in the drawdown zone, there is little attention paid to sites in the

drawdown zone. One disturbing aspect of the CRM program at Eufala is that the project staff sincerely believes that sites in the drawdown zone are mostly destroyed, which in fact may be the case. Consequently, they are reluctant to spend either time or manpower on the problem. It is well known that pothunters and collectors are scavenging the sites in the drawdown zone. Yet, there is only a token effort to curtail this kind of illegal activity.

Lake Barkley (Tennessee and Kentucky)

Shoreline sites are heavily collected by boaters during the annual fall drawdown. There have been no ARPA prosecutions and no Title 36 citations according to the cultural resource coordinator. The difficulty of catching people in the act is the reason given. There is no effort by project staff to coordinate with SHPO on the impacts of erosion and vandalism to individual sites.

Barren River Lake (Kentucky)

While there is some surface collection from exposed sites, serious pothunting, such as observed in Texas and Oklahoma, does not appear to be a major threat. No ARPA prosecutions or Title 36 citations have been issued. The District has an excellent plan to prevent or mitigate adverse effects to the significant sites at Barren River. If sufficient funds and manpower are made available to implement this plan, this small project could well serve as a model for CRM throughout the Corps of Engineers.

Bluestone Lake (West Virginia)

Erosion and surface collection have been observed at many of these sites by project personnel. To date, there have been no ARPA prosecutions although Title 36 citations have been issued for illegal digging in the vicinity of recorded sites. There is a draft HPMP that will be submitted for SHPO review upon completion. Monitoring and ranger patrols are routinely conducted during the winter drawdown for Sites 46SU3, 46SU9, and others.

Allegheny Reservoir (Pennsylvania and New York)

There have been no site protection projects in the drawdown zone. Monitoring and ranger patrols to thwart vandals during the drawdown is done infrequently. There have been no ARPA prosecutions or Title 36 citations issued. Long-term plans by the Corps and Forest Service call for the completion of the site inventory, testing of intact sites, and the mitigation/protection of historic properties.

Mansfield Hollow Lake (Connecticut)

Ranger patrols are used to thwart vandalism of exposed sites during the winter drawdown. While there is known collector activity, there are no ARPA prosecutions or Title 36 citations on record at the project. The project operational management plan (OMP) does address cultural resources and their management. A Historic Properties Management Plan is planned for the near future. There have been no data recovery projects or site stabilization projects at the lake.... Vandalism is not a major problem, but the surface collection from exposed sites is not being adequately handled at this time.

Ball Mountain Lake (Vermont)

There have been no ARPA prosecutions and few Title 36 citations involving cultural resources. Site monitoring is performed at irregular intervals, but there is no coordination with the State SHPO. The lake manager serves as the cultural resources coordinator. While there is a brief discussion of cultural resources in project OMP, there is no HPMP at this time. The major management goal is to control erosion at the one site in the drawdown zone that has been determined to be significant. In general, erosion rather than vandalism is the major problem at this project.

The law enforcement problem for reservoir drawdown zones involves both the Corps' budgetary policy toward cultural resources and a real manpower shortage that is reflective of the current downsizing of the Federal Government. Because of this, the problem will have to be addressed at a policy level and not simply as a technical or scientific issue. Nevertheless, the following recommendations would greatly improve the current situation:

- a. Each operating project should have a cultural resources coordinator in compliance with ER 1130-2-438 Section 11.c.2.
- b. The cultural resources coordinator should receive sufficient training to detect and report to the lake manager and the District's professional archaeologist(s) evidence of vandalism to identified historic properties in the drawdown zone.
- c. ARPA and Title 36 should be fully enforced at those sites that are determined to be "historic properties" (National Register eligible).
- d. The coordinator and all rangers at a Corps reservoir should receive adequate training in the enforcement of ARPA (such as the courses available through the Federal Law Enforcement Training Center (FLETC)).

- e. The lake manager should annually budget sufficient funds and request adequate personnel (FTE or contract) to enforce ARPA and Title 36 in the drawdown zone at those locations where historic properties are known to exist.

Use of Warning Signs

The collection of artifacts from the surface of archaeological sites in the drawdown zone is a recurring problem at most Corps reservoirs. Although not subject to the civil or criminal penalties of ARPA, the collection of projectile points or "arrowheads" from the surface of lands exposed during drawdowns for private purposes without an ARPA permit is prohibited. Illegal digging into these archaeological sites is less frequent than surface collecting but far more damaging to the research value of a site. Given the current manpower shortage, it is imperative for the Corps to do a better job in the management of visitor behavior at its projects.

In Dunn (1996), Gramann's (1991) research on the indirect management of visitor behavior was briefly discussed. The following recommendations were made for six frequently encountered violations:

Uninformed Violations: Increase visitors' awareness of harmful consequences to society and archaeological record of the site damage (e.g., public education and interpretation).

Responsibility-Denial Violations: Increase visitors' feelings of personal responsibility to help (e.g., site adoption programs).

Unintentional Violations: Increase knowledge of rules among target populations least likely to have this knowledge.

Releasor-Cue Violations: "De-fuse" releasor cues by removing them (i.e., remove evidence of prior vandalism by site rehabilitation or burial) or using educational messages that underscore they are not to be taken as guides to behavior.

Status-Confirming Violations: Promote deviant group's identification with protective models rather than with antisocial models (e.g., through site adoption programs).

Willful Violations: Unlikely to be affected by indirect management; direct management techniques necessary.

Gramann (1991:5) reported to the national audience of archaeologists and cultural resource managers at the 1991 WES workshop on archaeological site protection and preservation that his research on indirect management techniques showed that warning signs located near or immediately adjacent to

areas of potential violations have been effective in reducing damage to natural resources. Although educational signs also have been effective, warning signs have been more effective in direct comparisons. To be effective, the sign text must address specific violations at specific areas. General educational messages proved to be less effective. He also noted that the response of visitors to warning messages versus educational messages may vary according to personality traits. Unfortunately, Gramann's research did not focus specifically on cultural resources, so there is no systematic evaluation for the effectiveness of warning signs in deterring the vandalism of archaeological sites.

Based on one of the author's experience as a Corps District's senior archaeologist, the posting of warning signs immediately adjacent to significant archaeological sites is not recommended. This is particularly true in remote areas of the project that receive infrequent ranger patrols. In the words of one ranger interviewed during the 1995 field visits, it would be an invitation to "Dig Here."

A more effective technique is to place warning signs prohibiting illegal digging of archaeological sites in heavy visitor traffic areas, such as the lake's visitor center, the entrances to public use areas, boat ramps, etc. The effect of these signs would be to greatly reduce the number of "uninformed," "unintentional," and "responsibility-denial" violations. The placement, construction, and design of warning signs is an appropriate part of a lake's HPMP and any protection plan for those historic properties located in the reservoir draw-down zone.

Electronic Surveillance

In Dunn (1996), it was noted that the ranger serving as the cultural resource coordinator for Wright Patman Lake had installed electronic intrusion detection devices on several Caddo burial sites in the reservoir flood pool, which had become the targets of pothunters. This was the only instance during the 1995 field visits where electronic surveillance techniques were employed to prevent vandalism of a historic property. Its potential importance in preventing the vandalism of historic properties in drawdown zones appears to be very great.

Electronic surveillance technology should certainly be considered by all Corps cultural resource managers as an option in developing historic property protection plans. It could provide the means for successful ARPA prosecution of vandals when the manpower for regular site monitoring patrols is in short supply.

The effectiveness of the system at Wright Patman was effectively demonstrated during the 1995 field visit of one of the authors when a local high school class set off the buried seismic detectors. An alarm sounded in the project office during the course of the author's interview with the lake manager. The author and several rangers were on site within 10 min of the alarm

going off at the project office. Accompanied by their teacher and a local archaeologist, the students were engaged in a class project to pin-flag the numerous pothunter "dig-holes" in the historic Caddo cemetery. The students were impressed that the Corps cared enough to electronically monitor unauthorized digging on this significant site. The next section provides a brief description of the remote, unattended, ground sensing unit now being used at Wright Patman Lake near Texarkana, TX.

The PT-100 series that Eagle Telonics, Inc., has developed is used for long-term or semipermanent deployment. The following description is taken from the Operations Manual for the PT-100 Processor/Transmitter:

"The PT-100 incorporates sensor processing circuitry with a narrow band FM transmitter to relay sensor data back to a receiving site. The sensor processing circuitry, transmitter, and battery power source is self contained in a compact unit that facilitates storage, transportation, and concealment. The exterior case is constructed of durable injection molded polyethylene plastic. The PT-100's rugged waterproof case may be deployed either above ground or buried for covert monitoring. The single unit can receive, process and transmit information generated by seismic, infra-red and magnetic sensor probes either individually or in various combinations of deployment.

"The unit is easily programmed in the field at the time of installation with an EIDS handheld programmer (PG-400). The installer has the option to change frequencies, output power, sensitivity levels, active and inactive operating times plus a variety of other operational options. The internal cadance counter can also be adjusted to assist in the differentiation of humans, animals, and vehicles.

"The unit may also be programmed using any IBM compatible for desk-top computer utilizing MS-DOS language. Software is furnished to interface the computer to the PT-100 Processor/Transmitter" (Eagle/Telonics Manual:1).

It should also be noted that the PT-100 can be configured to provide the user with an external camera trigger. The trigger is activated each time a detection occurs. The camera trigger provides the user with an interface between the PT-100 and the camera. When the camera trigger is activated, the circuit is energized for 250 ms. Photographing the vandals in the act greatly facilitates the successful ARPA prosecution.

The new PT-200 series processor/transmitter offered by Eagle/Telonics is a smaller more compact unit first designed for tactical deployment by the U.S. military. Even with a smaller battery pack, users can expect up to 5 months of service without changing batteries. A feature of this system is the Seismic Animal Filter Program. This program is now included as standard equipment on the PT-100 as well. This technology filters out most nuisance alarms caused by animals, tree root movement, rainfall, and other seismic disturbances. This feature allows the user to deploy seismic detectors in areas they would have been ineffective before because of unidentifiable

seismic signals. The use of small electronic intrusion detection systems in culturally sensitive areas during drawdown events is certainly an idea whose time has come.

Interpreting the Resource

The goals of the Federal preservation effort are clearly set forth in the National Historic Preservation Act of 1966 (as amended 1980, 1992). Section 1(b)(2) of this landmark Act states that "the historical and cultural foundations of the Nation should be preserved as a living part of our community life and development in order to give a sense of orientation to the American people." Section 2(3) states that it shall be the policy of the Federal Government to "administer Federally owned, administered, or controlled prehistoric and historic resources in a spirit of stewardship for the inspiration and benefit of present and future generations."

To accomplish these lofty goals, historic properties must be interpreted to the public. It is important that drawdown zone historic properties should also be interpreted. As a first step, planning for the interpretation of these resources should be included in all project HPMPs and serious efforts undertaken for their interpretation to the public. This might include preparation of brochures, visitor center displays, and possibly even interpreted visits to selected sites during the drawdown period.

The Corps has prepared "A Guide to Cultural and Environmental Interpretation in the U.S. Army Corps of Engineers" (Propst and Roggenbuck 1981). Numerous supplements to this massive document have been prepared that give detailed guidance on a variety of techniques to increase the effectiveness of the Corps' interpretive program. However, the historic properties contained in reservoir drawdown zones appear to be rarely interpreted during their periods of accessibility (Dunn 1996:46-63). What if this were to change? What might result?

Gramann's research on the indirect management of visitor behavior may assist in answering this question. The onsite interpretation of historic properties was shown to be successful in reducing harmful behavior by organized youth groups visiting a Civil War battlefield at Shiloh, TN (Vander Stoep and Gramann 1987). It was most effective when the communication occurred immediately prior to exposure to resources. Gramann's analysis of these results is that personal communication may be more effective than impersonal communication (e.g., signs or brochures) in delivering messages describing protective rules and reasons for rules (awareness of consequences messages) (Gramann 1991:5).

The practical implications of this for the Corps' management of historic properties in drawdown zones is that the better job the Corps does in interpreting its cultural resources, inspiring and providing a sense of orientation to the public, the easier it will become to protect these resources from future

human impacts. The more people understand about the significance of archaeological sites and how they form an important part of their heritage as American citizens, the more likely it will be that uninformed and unintentional violations will decrease.

This is not to say that willful violations of ARPA and Title 36 will sharply decrease if the interpretation of drawdown zone historic properties are merely included in HPMPs. Pothunting for profit is a serious and potentially dangerous business in many parts of the United States. Here is where law enforcement and direct management techniques, such as electronic surveillance, will continue to be necessary to protect the resources to be interpreted.

8 Case Study 1: Barren River Lake, Kentucky

Management Problem

Barren River Lake is situated in Allen, Barren, and Monroe counties in south-central Kentucky (Figure 3). The dam is a rolled earth fill type with a random rock shell. Pertinent elevations include:

Dam top elevation	618 ft ¹
Dam height above streambed	146 ft
Winter pool elevation	525 ft; length = 21 miles
Summer pool elevation	552 ft; length = 33 miles
Total storage	590 ft; length = 46 miles

Construction began in March 1960, and the lake became operational in October 1964. A full range of development includes facilities for land- and water-based recreation, camping, fishing, boating, hunting, picnicking, and swimming.

Barren River Lake was first visited on June 22, 1995, during the initial field visits for the drawdown work unit. A summary description of the management practices observed there appears in (Dunn 1996:52). This project has received a large-scale preimpoundment survey, and several follow-up surveys of the drawdown zone have been conducted since its creation. Several testing projects have identified historic properties that meet the criteria of eligibility for the National Register of Historic Places. An excellent Historic Properties Management Plan has been prepared by the Louisville District archaeologist, Ms. Anne Bader.

The Mississippian Jewell Mound Site (15BN21) and the nearby associated sites, 15BN349 and 15BN384, were selected as the primary focus of the case study at Barren River because they are all National Register eligible sites

¹ A table of factors for converting non-SI units of measurement to SI units is presented on page xi.

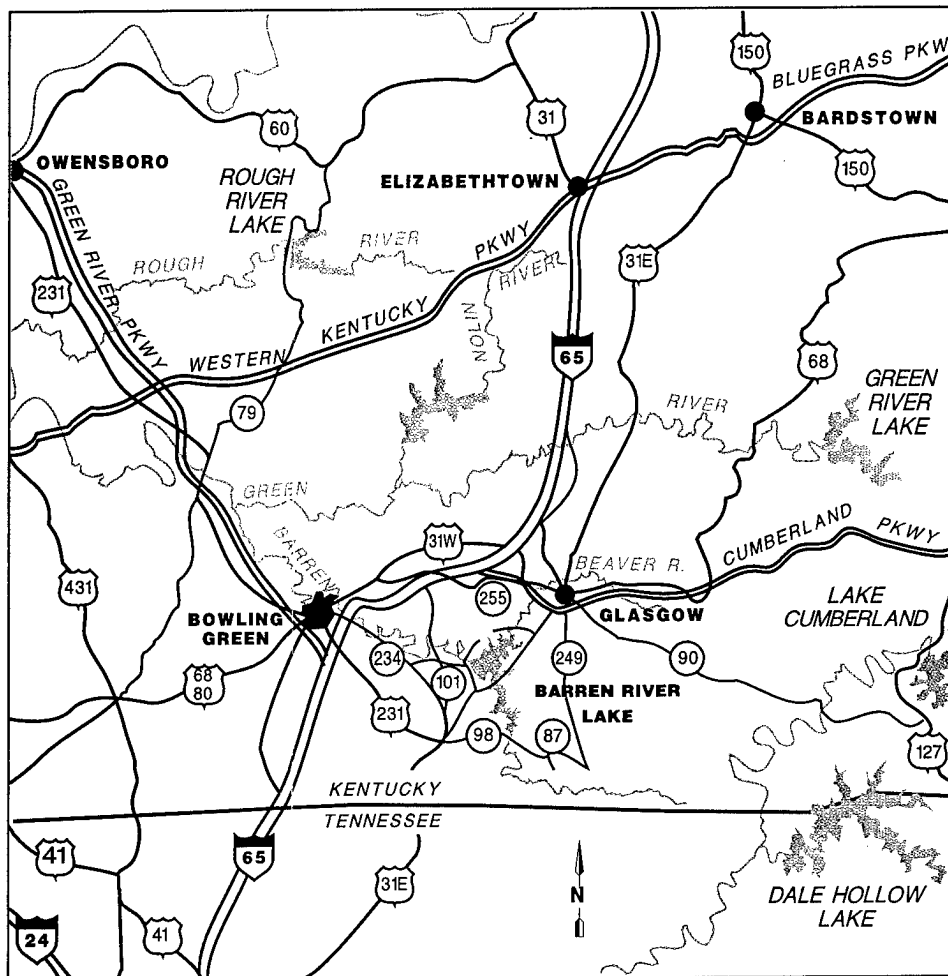


Figure 3. Barren River Lake: Project vicinity map

located in the drawdown zone that are being adversely affected annually by the normal operation of the lake. The Kentucky SHPO has expressed his concern over the erosion of these sites in a letter to the Louisville District (Figure 4) dated March 6, 1995. All three sites are located on a peninsula of land adjacent to Barren River State Park marina and golf course and are consequently vulnerable to vandalism when they are exposed (Figure 5). Onsite consultation with the Louisville District archaeologist revealed that there were two additional significant sites that could be used in the development of the case study, Sites 15AL329 and 15AL8.

Shoreline erosion of Barren River Reservoir in south-central Kentucky has substantially impacted cultural resources in the project area. Annual pool fluctuations of 25 to 30 ft from the winter (low) to the summer (high) pool levels has resulted in the vertical and horizontal translation of various erosional processes across the riparian project area several times a year for over 30 years. Geomorphic processes that have been particularly active in eroding archaeological sites in the project area include soil and rock erosion and



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March 6, 1995

David L. Morgan
Executive Director
and SHPO

Mr. Robert G. Fuller, Chief
Planning Division
U.S. Army Corps of Engineers,
Louisville District
P.O. Box 59
Louisville, Kentucky 40201-0059

**Re: The Jewell Site (15Bn21) and other Archaeological Resources
Barren Lake, Barren County, Kentucky**

Dear Mr. Fuller:

I am writing to you to express our concern about the condition of several archaeological resources located within the pool of Barren Lake and along its shoreline. In particular, we are concerned about the Jewell Site (15Bn21) and two nearby sites (15Bn349 and 15Bn384). These sites are eligible for listing in the National Register of Historic Places for their potential to contribute to our understanding of Mississippian lifeways. The Jewell Site contains the remains of a Mississippian town that dates from ca. A.D. 1200-1400. A cursory examination of this site revealed the presence of Mississippian houses, pits, hearths, and burials that have been exposed and adversely impacted by erosion of the site's plowzone and midden deposits. Although fluctuating lake levels and vandalism have adversely impacted the Jewell Site, it still contains important data on Mississippian settlement and subsistence patterns and ceremonial and religious lifeways. The site thus still retains sufficient integrity for inclusion on the National Register of Historic Places. Examination of nearby sites 15Bn349 and 15Bn384, which may be part of the Jewell site, indicates that these sites also contain intact Mississippian deposits and are eligible for listing in the National Register. Both, also are being impacted by shoreline erosion, and possibly vandalism. In particular, archaeological site 15Bn349 contains several stone box graves that are being impacted by shoreline erosion. In addition to these archaeological sites, I suspect that shoreline erosion also may be adversely impacting other important Mississippian sites.

I would very much appreciate your looking into this matter and seeing if anything can be done to recovery some of the information these sites contain before they are totally destroyed by erosion and vandalism. I look forward to hearing from you and if we can be of any further assistance please feel free to contact David Pollack of my staff at 502-564-7005.

Sincerely,

David L. Morgan, Director
Kentucky Heritage Council and
State Historic Preservation Officer



300 Washington Street
Frankfort, Kentucky 40601

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FAX (502) 564-5820

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Figure 4. Kentucky State Historic Preservation Officer's letter to Louisville District

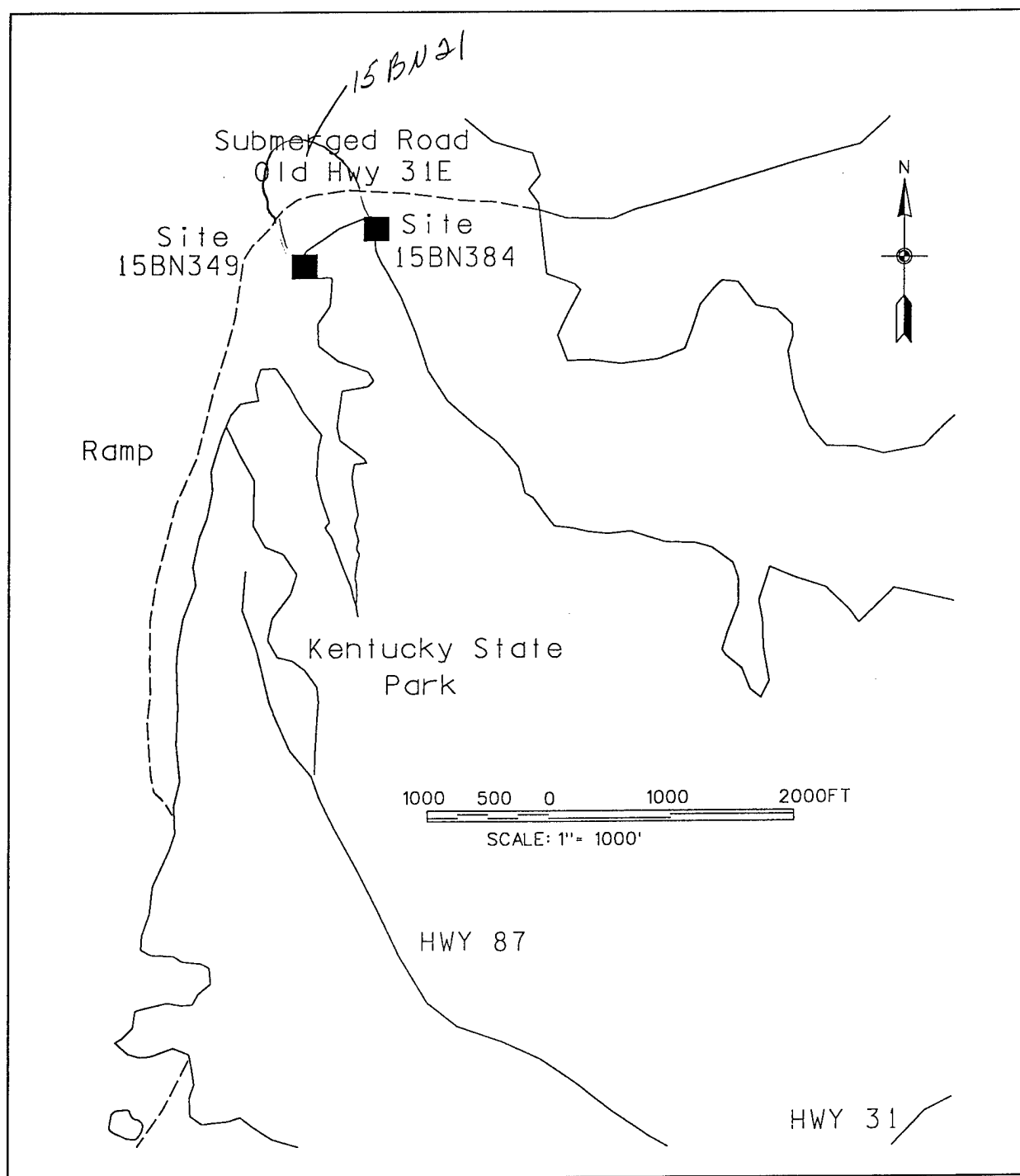


Figure 5. Sketch map showing relative locations of Sites 15BN21, 15BN384, and 15BN349 at Barren River Lake

artifact disturbance by waves and overland flow (surface runoff). Soils and rocks that form the foundation of archaeological sites that are susceptible to rapid decomposition by desiccation and hydration (wetting and drying) and chemical dispersion are also being rapidly eroded by reservoir fluctuations.

In an effort to determine the specific impact of geomorphic processes on cultural resources in the Barren River Reservoir project area, a number of "high priority" sites were examined in the field. Site visits were made during the period 20 through 22 February 1996, when the reservoir was drawn down to approximately the level of the "winter pool" (elevation 525 ft msl) (Figure 6). While 13 known archaeological sites were examined in the field, relevant geomorphological observations were made at five of the most significant sites, 15BN21, 15BN384, 15BN349, 15AL329, and 15AL8. Appendix A shows the geomorphology data sheets and site sketches for these sites.



Figure 6. WES team members Hollis Allen, Hugh Taylor, and Lawson Smith with Anne Bader

15BN21 (Jewell Mound)

The Jewell Mound Site is perhaps the single most significant prehistoric site within the Barren River Lake COE management area. The prehistoric site is located at the confluence of Barren River and Peter Creek. It is partially inundated during the summer, and subject to erosion. Furthermore, illegal collection occurs from this site on a regular basis during the winter drawdown of the lake when the site is completely exposed. This multicomponent site is comprised primarily of a Mississippian period temple platform mound, an associated village area, and prehistoric cemetery. Prior to the impoundment of Barren River Lake, a historic cemetery was also located near Site 15BN21. Evidence of this was seen during the WES team's inspection of the site

(Figure 7). The historic cemetery was moved to another location during the construction of the lake.

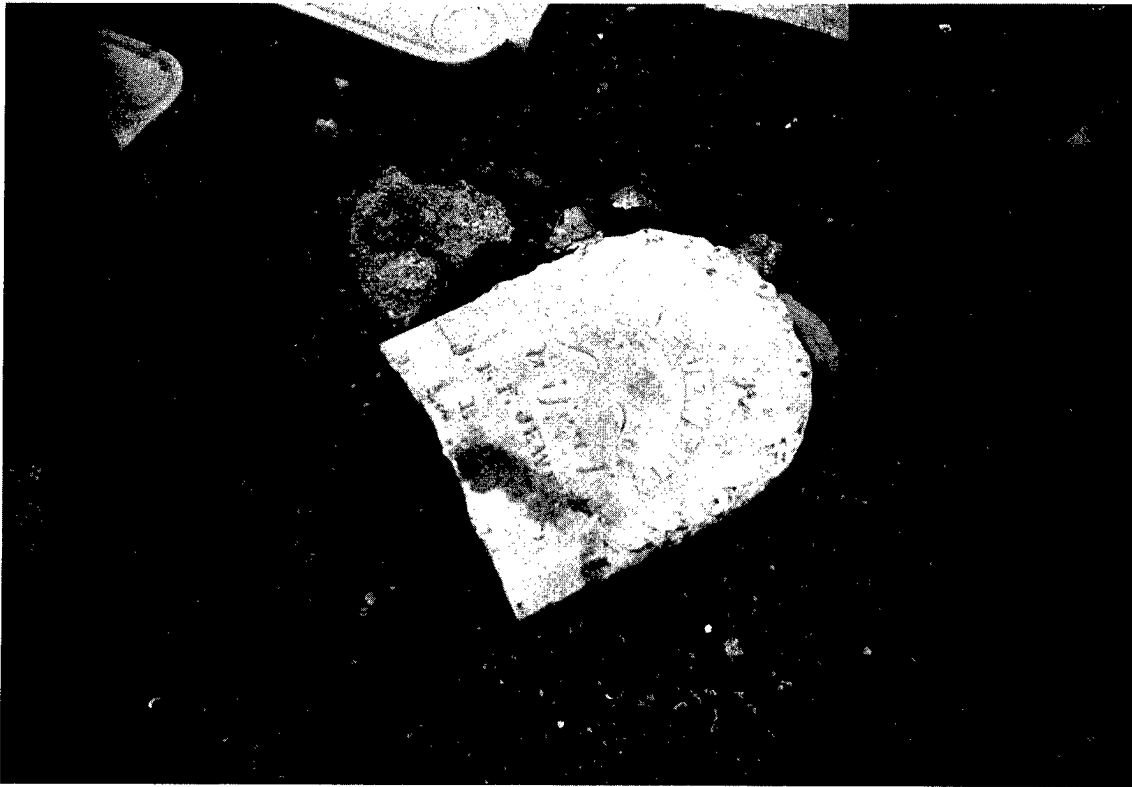


Figure 7. Broken tombstone from Jewell Family Cemetery at Site 15BN21

Jewell Mound is a low elliptical anthropogenic feature on the lower shoulder of a broad flat ridge adjacent to the confluence of Peter Creek and Barren River. Field observations of the site indicate that the mound may have been several meters in height and 60 to 80 m in diameter prior to recent erosion (Figures 8 and 9). The mound appears to be founded on a thick residual clayey soil developed in a silty shale. Since the filling of Barren River Reservoir, erosion from normal reservoir fluctuations has dramatically removed much of the upper 60 to 90 cm of soil from the site, destroying much of the historical record of the site. The principal processes of erosion have been wave swash and breaking as water depths on the site go from approximately 1 m to subaerial during rising and falling stages. These processes serve to disaggregate the soil, reduce its strength to resist erosion, and transport the soil off the site. During subaerial exposure of the site at low reservoir levels, erosion from raindrop impact and overland flow of runoff may also be effective in removing soil and parts of the record from the site.

Protection of the site from continued erosion from wave and runoff erosion could be a costly challenge. Fundamentally, the site surface would need to be protected from erosive processes. The substantial depth of water over the site during full reservoir level would probably make the use of vegetation



Figure 8. View of Jewell Mound (15BN21)



Figure 9. WES team (Taylor and Dunn) inspecting severely eroded Jewell Mound site (photo by Hollis Allen)

ineffective. Other approaches to surface protection (use of stone, soil sealers, reinforced fabrics, and geogrid) would be costly and a navigation hazard during certain reservoir stages. Data recovery may be a better alternative than site protection. A discussion of data recovery options for this site appears in the management summary section of the case study.

15BN384 and 15BN349

Site 15BN384 is described in the site inventory database as a large prehistoric multicomponent site that is inundated seasonally. Area N (north) has burials, pits, and the foundation of a historic house. Area S (south) has a large midden and no mounds; there are the foundations of a historic house. The site has not been formally evaluated for the National Register. Its close proximity to 15BN21 suggests that it may be part of the Jewell Mound complex. While the site has not been formally evaluated, the Kentucky SHPO regards it as potentially eligible for the National Register.

Site 15BN349 is described in the site inventory database as a large multicomponent site with stone box burials and pits. Because it is inundated seasonally, the integrity of the prehistoric cemetery has been destroyed. Its close proximity to the Jewell Mound site suggests its probable association with that Mississippian age site. While not formally evaluated, the Kentucky SHPO regards it as part of the Jewell Mound complex and therefore eligible for the National Register.

Geomorphic assessment

Probably the most challenging and culturally significant site visited is the 15BN384/15BN349 site complex. The site complex is situated on a long peninsula bounded by the reservoir on the east, north, and west sides. The peninsula actually consists of several recorded sites, including 15BN384 (Figures 10 and 11) and 15BN349 (Figures 13-15). The broad relatively flat surface of the landform, its occurrence adjacent to the modern floodplain of the Barren River, and the occurrence of several meters of fluvial gravels and sands beneath the surface indicate that the landform is a terrace of the Barren River Valley, a former floodplain of the Barren River abandoned when the river incised its valley over many tens of thousands of years. The terrace surface appears to be a continuous scatter of historic and prehistoric artifacts (Figure 12), suggesting that the entire landform should be treated as a single cultural resources management entity.

A sketch of the profile of Site 15BN384 (east-facing) shoreline is shown in Appendix A. The principal geomorphic processes that are contributing to the steady wasting of the site appear to be wave attack throughout the shoreline and hydration/desiccation of the sandy shale deposits underlying the terrace. Material is also being removed from the site by lesser amounts of overland



Figure 10. Hollis Allen examining village midden in eroding cut bank at 15BN384 (photo by Hugh Taylor)



Figure 11. Site 15BN384: Eroding shoreline at top of summer pool elevation (photo by Hugh Taylor)

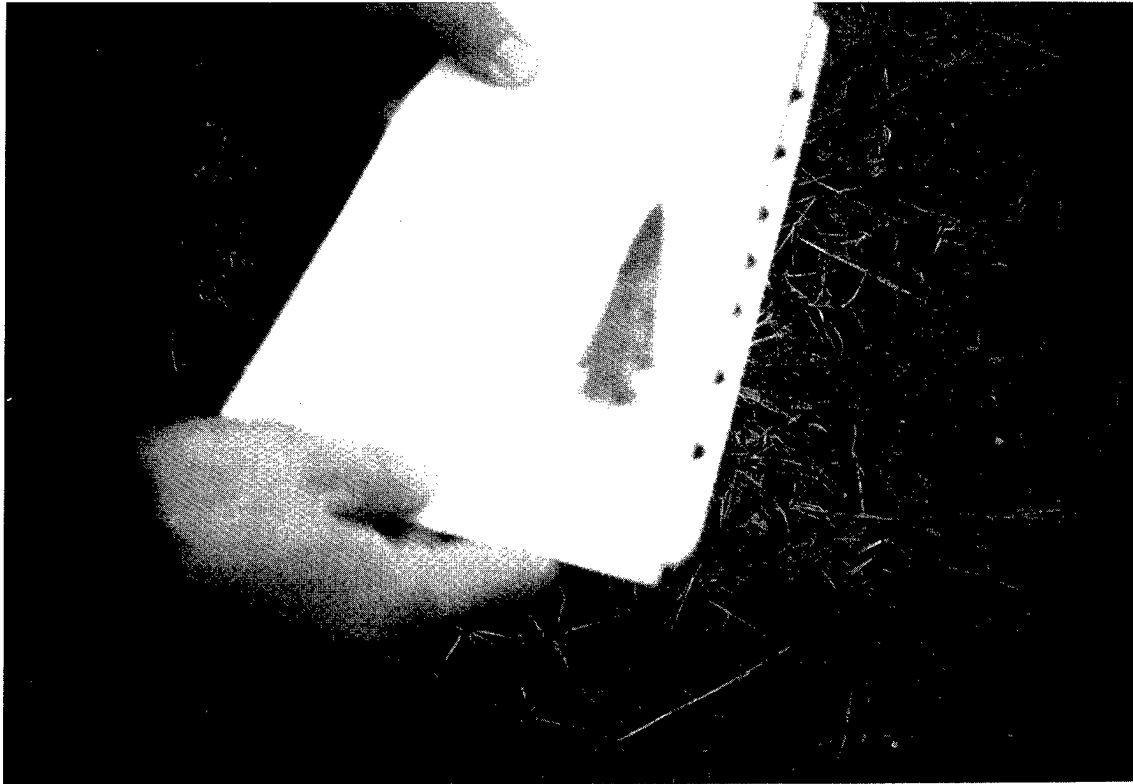


Figure 12. Corner-notched beveled projectile point/knife found at 15BN384



Figure 13. View of severely eroded shoreline at Site 15BN349



Figure 14. Site 15BN349: Stone box grave fragments dispersed by shoreline erosion and wave attack

flow erosion near the top of the shoreline escarpment and small mass failures of soil (a few centimeters in height) directly above the point of wave attack. As the reservoir is drawn down in the fall, the saturated shale on the shoreface dries and crumbles. When the reservoir is filled in the spring, waves dislodge the crumbled shale and wash it away. At the summer pool elevation, wave attack, followed by small soil mass failures continually remove the weathered alluvial deposits capping the terrace.

Arresting shoreline erosion at Site 15BN384 will be a substantial challenge and should be considered in terms of both short-term and long-term solutions. Immediate protection of the summer pool elevation on the shoreline could be

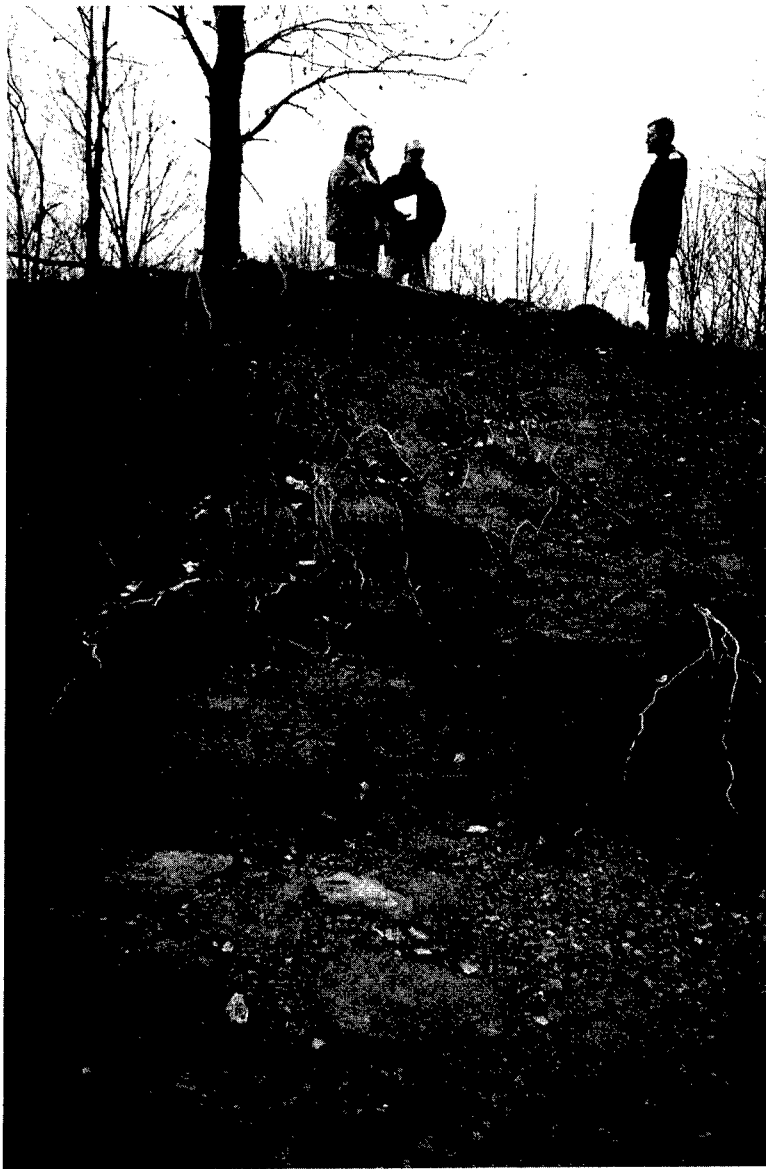


Figure 15. Ranger Lloyd Crabbe with Anne Bader and Robert Dunn at 15BN349 disarticulated stone box grave fragments in foreground

effected with local materials to provide enough time to evaluate options and costs for site data recovery. Long-term protection (if deemed necessary) should involve protection of the shale foundation of the site.

Bioengineering approaches

From cursory observations made during the two visits to the site complex, it appeared that most of the lower part of the peninsula had been subjected to high water above the summer pool elevation, e.g., flotsom, old logs that had apparently floated in. Woody vegetation on the peninsula consisted primarily

of black willow, buttonbush, cottonwood (*Populus deltoides*), and sycamore (*Platanus occidentalis*).

Site 15BN384 was severely eroded with an oversteepened to almost vertical 4- to 5-ft bank appearing at the summer pool elevation. Because the east side had a steep slope, was deep during summer pool, and was exposed to an average fetch of about one-half mile from the northeast and east, considerable erosion could occur from wind-driven waves. Additionally, substrata at the site consisted of weathered shale that deteriorated rapidly upon repeated wetting and drying. This would also cause erosion of the upper bank by promoting sloughing.

Site 15BN349 was also severely eroded with an oversteepened bank of about 6 to 7 ft at the summer pool elevation. The north and west sides were exposed to an average fetch of about 1 mile and a maximum northern fetch of 2 1/2 miles. This could cause considerable wind-driven wave erosion.

The following site protection actions are recommended to give the Louisville District enough time to conduct interim Phase 2 testing at these sites without expending an enormous amount of money. If testing reveals that the sites on the peninsula are indeed worthy of more protection, then other harder protection measures can be undertaken. There are two levels of expedient protection described below that offer options at both sites.

- a. The first level is very expedient and uses readily available materials found on or in close proximity to the site. This level consists of using the concrete slabs of old structures such as old houses, silos, etc., as revetment. This would be applied over a geotextile to serve as filter cloth. It would be applied first from just below summer pool to as high on the bank as the supply lasts. Additionally, a bioengineering fix would be applied that consists of using dormant willow posts. This consists of sinking long live willow posts down through the interstices of the concrete slabs. The rooting ability of the posts would help hold the soil together, and the sprouting ability of the posts would attenuate wave action and trap sediment. Additionally, the site would be covered with willow in 2 to 3 years, thus providing better aesthetics and fisheries habitat in the shade of the willow.
- b. The second level is somewhat expedient, but requires more transported materials and labor. For this level, a gabion breakwater is placed about 10 horizontal ft lakeward of the summer pool elevation. The gabion breakwater should extend well enough along the shoreline beyond any midden deposits or other artifacts to prevent flanking. The gabions would need to be secured tightly to the substrate with cables and anchors because they are subjected to high forces by waves and subsequent drawdown pressures when they are overtopped by high-water events. The escarpment, where there is one, should be shaved back to about a 1V:2H slope. Then, a brush mattress, like the one described above, should be installed.

If the District finds that the sites' significance justify data recovery, then a treatment such as a complete bank armorment with riprapped revetment may be warranted. A fix such as the one used for the marina breakwater across the bay would be a good example of the type to use. If the gabion breakwater was used while site investigation was proceeding, this could be reused as a toe from which to rebuild the eroded slope. Soil and rock fill could be placed shoreward of the breakwater.

Engineering approaches

The near surface materials are part of the Clarksville series soils that consist of well-drained, gently sloping to moderately steep, acid soils of the cherty, limestone uplands. These soils occupy moderately broad to narrow ridges. The surface layer is very friable cherty silt loam. The upper subsoil is yellowish-brown, cherty silt loam. There is a gradual transition to strong-brown, firm, cherty heavy silt loam to very cherty, clay loam in the lower subsoil. The root zone is deep. Moisture-supplying capacity and natural fertility are moderated. Permeability is moderately rapid. The Clarksville soils are somewhat difficult to till because of chert fragments. They can be cultivated throughout a wide range of moisture content without clodding or crusting. Most of these soils are cleared. The area of gently sloping to rolling Clarksville soils are used for pasture and cultivated crops. Second-growth hardwoods are on some areas of the steeper soils.

Bedrock exposed at the sites in question is highly weathered and subject to much greater degradation due to the repeated drawdowns and wave action. The soils described above and observed at these sites are not highly erodible on slopes of about 0 to 12 percent. But the combination of relief at this site and reservoir fluctuations have contributed to the erosion of all of the soil from elevations below the summer pool and contributed to the steepening and undercutting of the bedrock on the east-facing slope (Site 15BN384).

Any temporary or permanent site protection must consider the frequent overtopping of the site fix and the associated wave actions. The pore pressures generated behind and beneath such fixes must be allowed to dissipate through a filter medium without removing fine materials and weathered rock fragments.

The proposed expedient use of concrete foundation debris for toe protection at the level of the summer pool should be placed on a prepared surface covered with a geotextile overlaid with about 4 in. of bedding material to protect the fabric during placement. This protection should be taken to hard points (stable areas) to each side of the site or well past the site to allow for flanking at the end conditions of the fix.

15AL329A

This is a multicomponent site that is situated on a ridge that is partially inundated during the summer pool level. While Archaic and Middle Woodland components are known to exist at this site, the most significant aspect is the presence of a Mississippian stone box cemetery. Five graves were excavated in 1970, and two others in 1974. One of the graves produced a radiocarbon date 560 ± 100 B.P. or A.D. 1390. Eight additional graves were excavated in 1981. Surface materials collected at the site in 1981 include Mississippian triangular projectile points, a Baker's Creek projectile point, numerous bifaces, drills, chert debitage, and animal bone. All but one of the eight stone box graves excavated in 1981 had been totally or partially destroyed, leaving only the stone linings of the burial. The fragile remains of a young child were recovered from one intact burial. No grave goods were recovered, but it was noted that this is common for Mississippian stone box graves of this area. From the inspection of this site, it was concluded that additional graves will continue to be exposed by erosion.

Geomorphic assessment

This site is located across the Barren River Valley from Site 15BN384. It also is a Barren River terrace, however, less well developed than the terrace at Site 15BN384 and separated from the Barren River floodplain by a long upland slope. The fluctuation zone of the reservoir traverses the gradual incline of the hillslope below the terrace as the pool is filled in the spring, with the summer pool elevation occurring at the top of the hillslope and near the base of the thin alluvium on the terrace. The remains of several box graves have been discovered near the top of the fluctuation zone, and the shoreface is littered with lithic debris from tool manufacture (Figures 16-18).

Observations of the shoreface suggest that approximately 70 to 90 cm of soil has been eroded from the site since closure of the reservoir. Geomorphic processes active in removing the soil are wave attack, hydration/desiccation of the sandy shale deposits on the shoreface of the hillslope below the terrace, and small amounts of overland flow and soil dispersion. Protection of the site from continuing erosion from reservoir fluctuation would be a significant challenge and would entail the installation of a solution that would protect a broad, long shoreface from wave attack and hydration/desiccation.

Bioengineering approaches

The primary vegetation at the site was at or above the elevation contour that coincided with the summer pool elevation, 552 ft mean sea level (msl). This vegetation consisted mostly of black willow (*Salix nigra*) and buttonbush (*Cephalanthus occidentalis*). It was noteworthy that in spots along the peninsula that contained this site, several willow stands were holding the shoreline



Figure 16. Site 15AL329: Highly eroded surface with disarticulated stone box graves (photo by Hugh Taylor)



Figure 17. Vegetative mat just above summer pool elevation at 15AL329

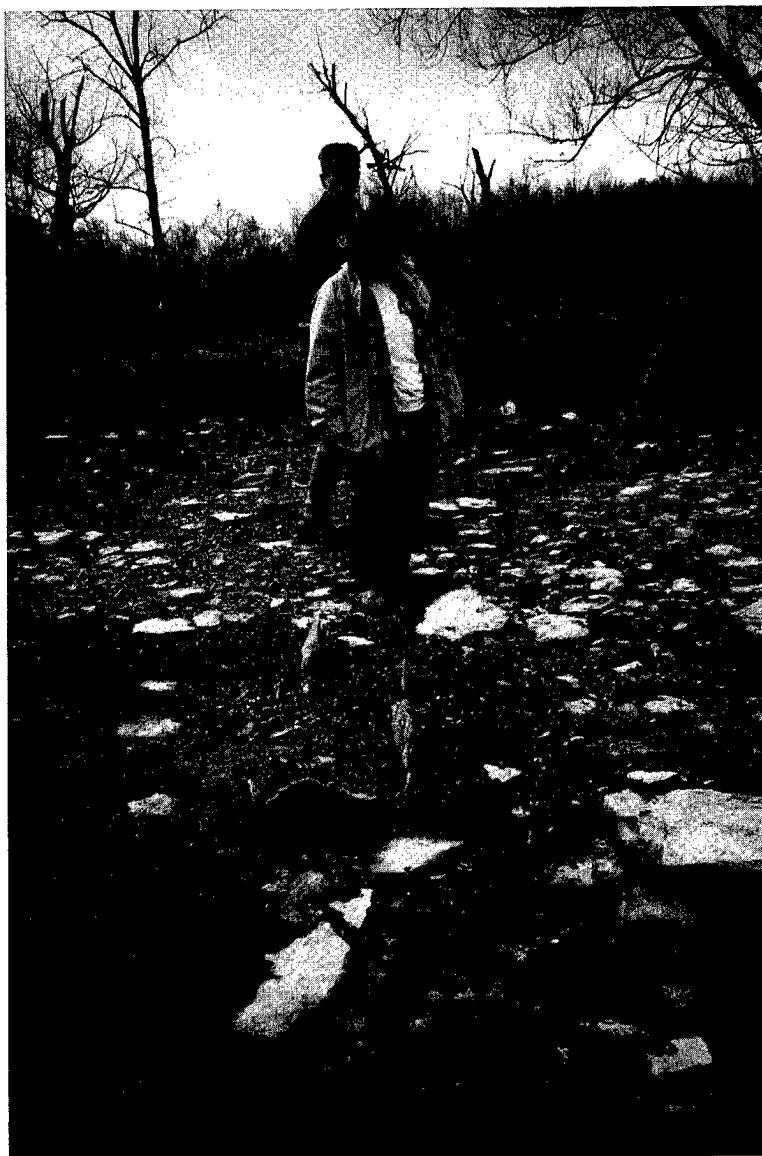


Figure 18. Site 15AL329: Anne Bader and Hugh Taylor viewing disarticulated stone box graves

in place (Figure 17). The willow contained young saplings with a dense root mass that was impenetrable to waves. The shore geometry was gradually sloping lending itself to some sort of bioengineering stabilization, i.e., a combination of vegetation and low-cost materials and structures. Soils at the site that were at or above summer pool tended to be well drained and appeared to be sandy silty clay. At the summer pool elevation, there was about a 2-ft escarpment that was a result of wind-driven wave action.

This site lends itself to bioengineering stabilization if site protection is deemed necessary by appropriate authorities. The bioengineering fix consists of a combination log breakwater and flood-tolerant vegetation landward of the

breakwater. The breakwater would be similar to the log breakwater described in Allen (1991:6-8) and would be anchored in a similar manner. Old logs are apparently plentiful near this site and could be dragged or floated in place. Flood-tolerant vegetation recommended would be primarily black willow, buttonbush, switchgrass (*Panicum virgatum* var. Kanlow), maidencane (*P. hemitomon*), softstem bulrush (*Scirpus validus*), cattail (*Typha latifolia*), and other similar species.

The log breakwater would be installed at a point about 30 ft lakeward of the escarpment. It would serve to break waves and allow the flood-tolerant vegetation to become established. Several logs would be overlapped so as to form about a 3-ft-wide breakwater. This would extend in length around the point of the peninsula on both sides to as far as necessary to protect the site.

Living willow and buttonbush would be placed in the form of a brush mattress and wattling combination described in Allen and Klimas (1986:57-64). The brush mattress would be placed along the summer pool elevation at the same elevation as the escarpment. This would be done after the escarpment is shaved back to a fairly smooth slope. Care should be taken, however, to leave existing vegetation in place that is serving to stabilize the shoreline.

Lakeward of the woody vegetation described above would be herbaceous plantings of switchgrass, maidencane, softstem bulrush, and cattail. These would be planted as rooted sprigs on 0.5-m centers.

All of the above could essentially be done by volunteer labor, such as Boy Scouts, Girl Scouts, etc. However, it would be best if WES could conduct a workshop with these groups prior to intensive work in order to illustrate appropriate construction and planting techniques. This could be part of Barren River Lake Project's "Educational/Interpretive Program." Such an effort would give local citizens pride in the protection plan and a sense of ownership of this significant site.

15AL8

This is a large multicomponent prehistoric site that has been recorded as having four activity areas. Three of the areas are inundated seasonally (B, C, and D). Area A is only inundated at flood stage. Area C is recorded as a Mississippian component. All areas have yet to be formally tested for the National Register. Area B is regarded as potentially eligible for the National Register, while the other areas remain unassessed. All areas are described as "open without mounds."

Geomorphic assessment

Unlike the two previously discussed sites, Site 15AL8 occurs next to the Barren River in the upstream reach of the reservoir. The site is the location of one of several previously identified artificially constructed mounds. Located immediately adjacent to the Barren River, the mound is situated on top of a low (approximately 2 m above the floodplain) fluvial terrace (refer to Appendix A). The mound has been eroded by both waves (as the reservoir level rises and falls on the mound) and streamflow. Several stumps on the site indicate that 40 to 60 cm of the original soil surface has been removed by these processes since the closure of the reservoir. Fine-grained silty sediments are also accumulating on the site during the falling stage of the reservoir to depths of 20 to 30 cm. These sediments are probably being stored in this constricted part of the reservoir until the next substantial filling event occurs and the easily eroded silts are moved downstream into the main pool of the reservoir (Figures 19-22).



Figure 19. Site 15AL8: View from mound

Site 15AL8 may offer a relatively unique opportunity to protect valuable cultural resources. When the mound was constructed by Mississippian people, older artifacts were buried by the mound on the terrace surface. In almost every other location of the terrace in the project area, the surface has been either heavily eroded and/or heavily collected, resulting in substantial



Figure 20. Site 15AL8: View of eroded terrace adjacent to river



Figure 21. Site 15AL8: Hugh Taylor examining site during winter drawdown



Figure 22. Site 15AL8: Eroded mud flat adjacent to mound

destruction of the archaeological record. Protection of Site 15AL8 will not only result in protection of the mound, but also protection of older artifacts buried in and beneath the mound.

Engineering approaches

The near-surface materials are typically the Christian and Trimble Soil Series. The Christian Series consists of deep, well-drained, moderately permeable soils that formed in residuum of old alluvium weathered from interbedded sandstone, siltstone, shale, and limestone. These soils are on ridgetops and side slopes. Some areas are karst. Slopes range from 2 to 20 percent. The top soil is 40 to 60 in. or more thick. Depth to bedrock is more than 60 in. Chert, sandstone fragments, or pebbles range from 15 to 35 percent in the upper horizon and from 0 to 35 percent in the B horizon; reaction ranges from neutral to extremely acid. The upper soil horizon texture is gravely silt loam or gravely silty clay loam. The lower horizon texture is clay loam, silty clay loam, silty clay, or the gravely analogs.

Site 15AL8 contains a mound in the river floodplain next to the winter pool river channel. Deposition has occurred over the site. The use of geotextiles and articulated concrete blocks as suggested by Shields' site protection

matrix (1991: Figure 12) and discussed in Dunn (1996:20-22) should be considered.

Table 1 shows the potential solutions and concerns associated with each site at Barren River Lake. A range of site protection methods were considered for these sites. In general, flexible economical erosion control fixes have been recommended in combination with vegetation. Geoweb can be constructed vertically and horizontally depending on the site requirements. It can be used with or without a rock toe and with vegetation where feasible. Damaged vegetated fixes potentially heal with time without immediate maintenance.

Table 1 Potential Erosion Control Methods for Barren River Archaeological Sites in the Drawdown Zone				
Site	Predominant Erosion Mechanism	Additional Design Concerns	Site Protection Method	Comments/Recommendations
Barren River, Kentucky 15BN21	Wave, overtopping, drawdown		N/A	Data recovery recommended
Barren River, Kentucky 15BN384	Wave, overtopping, drawdown	Steep slopes, weak rock, high acidity	Cobble revetment/ Geoweb w/rock toe	Duration of overtopping, fix between hard point
Barren River, Kentucky 15BN349	Wave, overtopping, drawdown		Cobble revetment/ Geoweb	
Barren River, Kentucky 15AL329A	Wave, overtopping, drawdown	Corrosion	Cobble revetment/ Geoweb	Willow roots created hard points; acidity
Barren River, Kentucky 15AL8	Wave, overtopping, drawdown	Corrosion	Cobble revetment/ Geoweb	Looting is a problem; acidity

Management Summary

15BN21 (Jewell Mound)

The WES team recommends that archaeological data recovery, rather than site protection, be undertaken at this site. The substantial depth of water over the site during the summer reservoir level would probably make the use of vegetation ineffective. Other approaches to surface protection (use of stone, soil sealers, reinforced fabrics, and geogrid) would be costly and a navigation hazard during certain reservoir stages.

The site should be tested to determine the depth and integrity of the remaining cultural deposits. Depending on the testing results, a data recovery plan should then be prepared and coordinated with the Kentucky SHPO. Ideally, the number, size, and location of the excavation units should be developed by the archaeologist performing the testing, in close coordination with the Louisville District archaeologist.

Following SHPO consensus on the data recovery research design, coordination with the Advisory Council should be undertaken pursuant to 36 CFR 800. Upon Council approval in the form of a "no adverse effect" concurrence or the Council's approval of a Memorandum of Agreement that calls for the implementation of the research design, sample excavation of the site should be undertaken during the winter drawdown period. Water screening of the soil matrix from each level of each unit, flotation of feature fill, the laboratory analysis of faunal and botanical remains, and the typological and use-wear analysis of all artifacts from the excavation units should be undertaken. The preparation of a comprehensive report on the field and laboratory research would complete the mitigation of adverse effect.

15BN384

Additional testing should be undertaken to determine the total extent of the site and its relation to 15BN349. This is currently being planned by the Louisville District archaeologist for the summer of 1996. The site protection plans discussed by Hugh Taylor and Hollis Allen are recommended.

The short-term plan recommended by Hollis Allen is comprised of two levels. The first level uses readily available materials found on or in close proximity to the site. This level consists of using the concrete slabs of old structures such as old houses, silos, etc., as revetment. This would be applied over a geotextile to serve as filter cloth. It would be applied first from just below summer pool to as high on the bank as the supply lasts. Additionally, a bioengineering fix would be applied that consists of using dormant willow posts.

The second level requires more transported materials and labor. For this level, a gabion breakwater is placed about 10 horizontal ft lakeward of the summer pool elevation. The gabion breakwater should extend well enough along the shoreline beyond any midden deposits or other artifacts to prevent flanking. The gabions would need to be secured tightly to the substrate with cables and anchors because they are subjected to high forces by waves and subsequent drawdown pressures when they are overtopped by high-water events. The escarpment, where there is one, should be shaved back to about a 1V:2H slope. Then, a brush mattress, like the one described above, should be installed.

The long-term site protection plan is a treatment such as a complete bank armorment with riprapped revetment. A fix such as the one used for the

marina breakwater across the bay would be a good example of the type to use. If the gabion breakwater was used while site investigation was proceeding, this could be reused as a toe from which to rebuild the eroded slope. Soil and rock fill could be placed shoreward of the breakwater.

15BN349

The protection plan, both short-term and long-term, for this site is the same as that recommended for 15BN384. Dr. Lawson Smith hypothesizes that the entire peninsula where these sites are located could legitimately be regarded as a "site." The terrace surface appears to be a continuous scatter of historic and prehistoric artifacts, suggesting that the entire landform should be treated as a single cultural resources management entity. The testing planned at 15BN384 for the summer of 1996 should effectively test this hypothesis. If true, a detailed plan for the long-term management of the terrace landform should be prepared. Portions of the landform (e.g., 15BN384 and 15BN349) that are threatened by erosion should be protected expeditiously.

15AL329A

The major feature of this site, the prehistoric "stone box cemetery," is essentially destroyed. Testing is recommended to determine if there are additional burials or features in the adjacent terrace escarpment just at and above the summer pool elevation. If there are intact cultural deposits in this area, then the protection of these deposits becomes appropriate. This site, or new activity area of 15BN329, would have to be determined eligible prior to undertaking the protection measures described below.

Hollis Allen has recommended a bioengineering protection plan that consists of a combination log breakwater and flood-tolerant vegetation landward of the breakwater. The breakwater would have to be anchored. Old logs are apparently plentiful near this site and could be dragged or floated in place. The log breakwater would be installed at a point about 30 ft lakeward of the escarpment. It would serve to break waves and allow the flood-tolerant vegetation to become established. Several logs would be overlapped so as to form about a 3-ft-wide breakwater. This would extend in length around the point of the peninsula on both sides to as far as necessary to protect the site. Flood-tolerant vegetation recommended would be primarily black willow, buttonbush, switchgrass, maidencane, softstem bulrush, cattail, and other similar species.

Living willow and buttonbush would be placed in the form of a brush mattress and wattling combination. The brush mattress would be placed along the summer pool elevation at the same elevation as the escarpment. This would be done after the escarpment is shaved back to a fairly smooth slope. Care should be taken, however, to leave existing vegetation in place that is serving to stabilize the shoreline. Lakeward of the woody vegetation

described above would be herbaceous plantings of switchgrass, maidencane, softstem bulrush, and cattail. These would be planted as rooted sprigs on 0.5-m centers.

15AL8

Phase 2 testing is recommended at this site to determine the presence and condition of postulated buried cultural deposits. Dr. Lawson Smith has argued that this is the location of a previously identified mound site whose provenience had been lost over time. If so, Site 15AL8 offers a relatively unique opportunity to protect valuable cultural resources. Older cultural components may be buried under the mound that was constructed on the terrace surface. In almost every other location of the terrace in the project area, the surface has been either heavily eroded and/or heavily collected, resulting in substantial destruction of the archaeological record.

Protection of Site 15AL8 will not only result in protection of the mound, but also protection of older artifacts buried in and beneath the mound. Development of a detailed protection plan is recommended if the site is determined eligible for the National Register. One possible protection plan would include the use of geotextiles and articulated concrete blocks to prevent erosion of the mound and underlying cultural strata. The preparation and implementation of a monitoring plan for this potentially important site is highly recommended.

9 Case Study 2: Bluestone Lake, West Virginia

Management Problem

Bluestone Lake in southern West Virginia was first visited on August 1, 1995, during the initial field visits for the drawdown work unit (Figure 23). A summary description of the management practices observed there appears in (Dunn 1996:54). There are a total of 103 archaeological sites located on COE property within the boundary of the Bluestone Reservoir. According to the project's draft HPMP, this includes 55 prehistoric open-habitation sites, 4 prehistoric rockshelters, 10 prehistoric village sites, 4 prehistoric hamlets, 4 historic military fort sites, 8 historic residential sites, 10 historic industrial sites, and 2 sites of reported historic use.

Bluestone Lake was selected as a case study because of the Barker Site (46SU3), a very important late prehistoric Fort Ancient village located in the 4-ft reservoir drawdown zone, and a number of other prehistoric villages (e.g., 46SU22 and 46SU20) in the Crumps Bottom area that are regularly impacted by flood events. At the time of the WES team visit, the Crumps bottom sites had recently emerged from 85 ft of floodwater storage (Figure 25). All three sites were visited by the WES team during the winter drawdown in March 1996. Descriptions of these sites have been provided by the Huntington District archaeologist, Dr. Robert Maslowski, or appear in the draft HPMP which he authored.

Normal operation of Bluestone Reservoir has resulted in some local shoreline erosion throughout the reservoir. Unlike water storage reservoirs that typically experience pool fluctuations of tens of feet, Bluestone Reservoir is typically operated within a 4-ft prism. The pool is maintained at approximately 1,410 ft msl during the summer and 1,406 ft msl during winter. Daily fluctuation of 1.5 ft is typical. Geomorphic processes that have been active in destroying archaeological sites along the reservoir shoreline include those produced by waves, overland flow, and streamflow and reservoir currents.

Geologic materials that make up the shoreline of Bluestone Reservoir are quite variable but may be lumped into three general conditions. In the lower

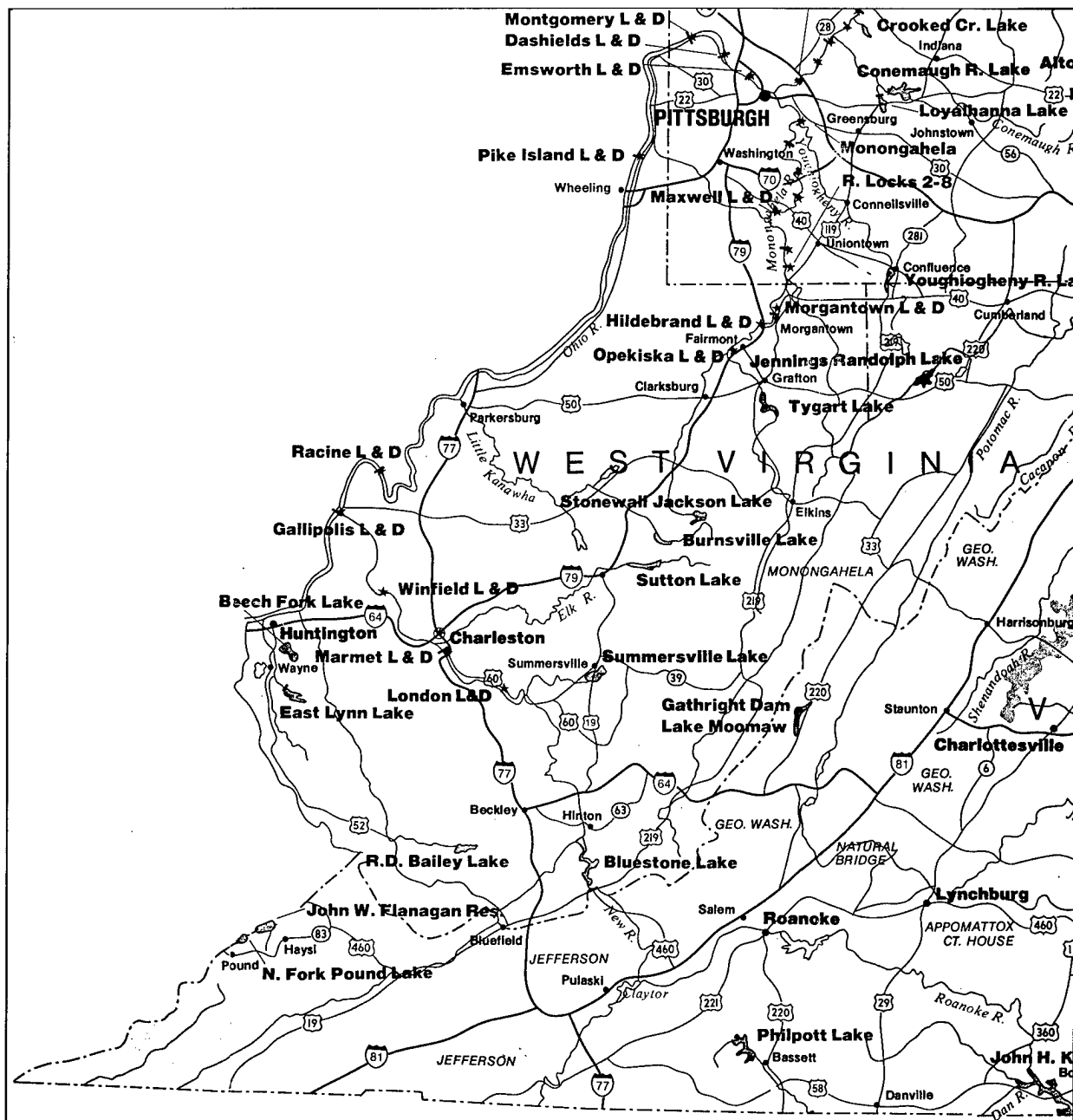


Figure 23. Bluestone Lake: Project vicinity map

end of the reservoir, the shoreline is comprised of local "bedrock" of sandstones and shales of the Upper Mississippian-age Hinton Group. These well-indurated Paleozoic sedimentary rocks are relatively resistant to erosion and somewhat resistant to mass failure along the shoreline. Where the reservoir encounters these rocks in place, the profile is usually steep and stable. Upstream of the lowermost reach of the reservoir, the shoreline is often composed of colluvial deposits of the Hinton Group and small alluvial fans produced by local tributaries to the New River. Near the community of Bertha,

New River alluvial deposits begin to be exposed in the shoreline, primarily in the form of terraces. From this point (approximately River Mile 6 in Bluestone Lake) upstream, the shoreline is alternatively comprised of alluvial deposits in the inside of bends and relatively steep rock slopes on the outside of bends. Occasionally, alluvial and colluvial fans occur along the shoreline on both sides of bends. Of the three general types of geologic materials along the shoreline, the most resistant to erosion are the shore faces composed of in situ rock. The least resistant to erosion are the New River alluvial deposits of the terraces and floodplain. Colluvial and alluvial fan deposits are intermediate in erosivity between in situ rock and alluvium. The three sites visited were all situated on New River terraces (alluvium). Appendix A shows the geomorphology data sheets and site sketches for these sites.

Barker Site (46SU3)

This is a large Fort Ancient village that is located on the southern tip of an island in the New River approximately 8 km southeast of the confluence of the New River and the Bluestone at elevation 1,408 ft AMSL with the major portion of the site being inundated by Bluestone Lake. It is briefly exposed during the winter drawdown. The site has Late Prehistoric, Late Archaic, and Proto-Historic temporal components and Bluestone, Puert, Radford, Page, and Savannah River cultural components. The site has been known under several different names.

The site has produced many artifacts as well as burials. A flood in 1891 is reported to have exposed an ancient graveyard covering approximately 40 acres. The site has also produced a sandstone turtle figure that is now housed at the Smithsonian Institution. Solecki (1949) excavated a 10- by 15-ft test trench and recovered 131 pot sherds, along with few flint flakes, and some worked bone.

The University of Pittsburgh conducted testing at 46SU3 in 1977 (Apple-garth, Adovasio, and Donahue 1978). The goals of the testing were to (a) gauge the effects of inundation, (b) delineate the extent of the archaeological deposits, and (c) gather artifacts and data on the prehistoric inhabitants of the Bluestone Reservation for a newly constructed interpretive center. Additional controlled surface collections and test excavations were conducted in 1978 and 1979 by the University of Pittsburgh for the Corps and the National Park Service. Many features were exposed during these excavations, including roasting, storage and trash pits, occupational floors, extensive midden areas, and burials. Thousands of artifacts have been collected from this site during testing and surface collection. Diagnostic artifacts recovered from the site include two Levanna and one Pee Dee projectile points, shell-tempered and New River series ceramics, and a glass trade bead. This site has been determined eligible for the National Register of Historic Places, but has not yet been nominated by the West Virginia State Historic Preservation Office (SHPO).

Geomorphic assessment

Located on a low terrace of the New River, the landform that contains Site 46SU3 is now inundated by the normal summer pool. Annual transgression of the rising pool in spring and regression of the falling pool in the fall has resulted in erosion of approximately 70 to 110 cm of surficial soil from the site. The creation of the reservoir left the small ridge on the low terrace (which may have been the nucleus of the prehistoric occupation area) as a narrow island (Figure 24). The upstream end of the island has been subjected



Figure 24. View of 46SU3 (island) from uplands

to erosion from streamflow, reservoir currents, and waves. These erosional processes have removed the silty-sandy alluvial matrix of the archaeological record and left behind the heavier cultural artifacts of ceramics, bone, lithics, and manuports along a shelf that extends downstream approximately 300 ft (Figures 26-28). Consequently, the cultural artifacts that may have been distributed through a vertical alluvial section of 110 cm now comprise a pavement on the shelf exposed on the upstream end of the site. Although sedimentation does occur on the shelf during high flows (several inches of silty sand were apparently deposited in February 1996), the net sediment budget is negative and erosion is the result. Downstream of the eroded shelf, the island is experiencing sedimentation during the falling stages of high flows. This upper surface on the landform is covered by trees that show evidence of progressive burial by New River fine-grained sediments. The archaeological



Figure 25. Bluestone Lake: Trash line showing elevation of 85-ft flood storage in January/February 1996



Figure 26. WES team onsite at 46SU3



Figure 27. View of "island" at 46SU3 from village midden area



Figure 28. WES geomorphologist Dr. Lawson Smith at 46SU3 with project manager Mr. David Eskridge

record on this part of the landform is probably buried by several feet of fine-grained (clayey, sandy silt) alluvium.

Protection of the site from future destruction from erosional processes will most likely require a scheme that will change the site from a location of sediment removal to one of sediment accumulation. The scheme will have to take into consideration a reservoir level fluctuation of 4 to 5 ft across the site and the situation of the site on the nose of an eroding island comprised of relatively erodible materials. One such solution might involve the placement of a rock structure (such as a riprap groin) upstream of the site that would divert flows away from the site and trap sediment behind it on the eroded shelf (Figure 29). The newly deposited sediment could be planted in an appropriate vegetation that would cause further sedimentation and site stability.

Bioengineering approaches

This site consists of an island that used to be a terrace along the old floodplain of the New River. The island contains bottomland hardwood vegetation consisting mostly of black willow (*Salix nigra*). At the upper end and to the lakeward side of the island, an escarpment of about 2 ft occurred as a result of erosion from both scour during drawdown and wind-driven waves. At the edge of the escarpment occurs scattered shrubs and trees, mostly black willow, that are slowing erosion. On the upper end of the island, there is a peninsula that contains evidence of scattered artifacts of various ages.

This site could be protected by bioengineering methods if considered warranted from a cultural resource perspective. The recommended treatment would consist of the following:

- a. Protecting the eroding upper end of the island with a combination of a transverse rock dike and planted vegetation shoreward of the dike.
- b. Controlling erosion of the undercut bank on the main part of the island (left-descending bank of the river).

For the upper end, it is recommended that a transverse rock dike be run from the shore out to and beyond the upstream point of the island. The end of the dike would be curved or hooked and pointed downstream (see Figure 29). This would be a current deflection structure and tend to keep currents and waves off the upper end of the island. It would also create a calm water zone, and the area behind it would tend to accumulate fine sediments. After sediments build up and reach a point of equilibrium (probably about 1 year after construction), the area of deposition would be planted with wetland vegetation. This would consist of both emergent aquatic vegetation in the deeper water zones (5 to 10 in. of water at summer pool elevation) to shrubby woody vegetation in the shallow water zones (0 to 5 in. of water at summer pool elevation). The crest of the transverse dike should be at or about the

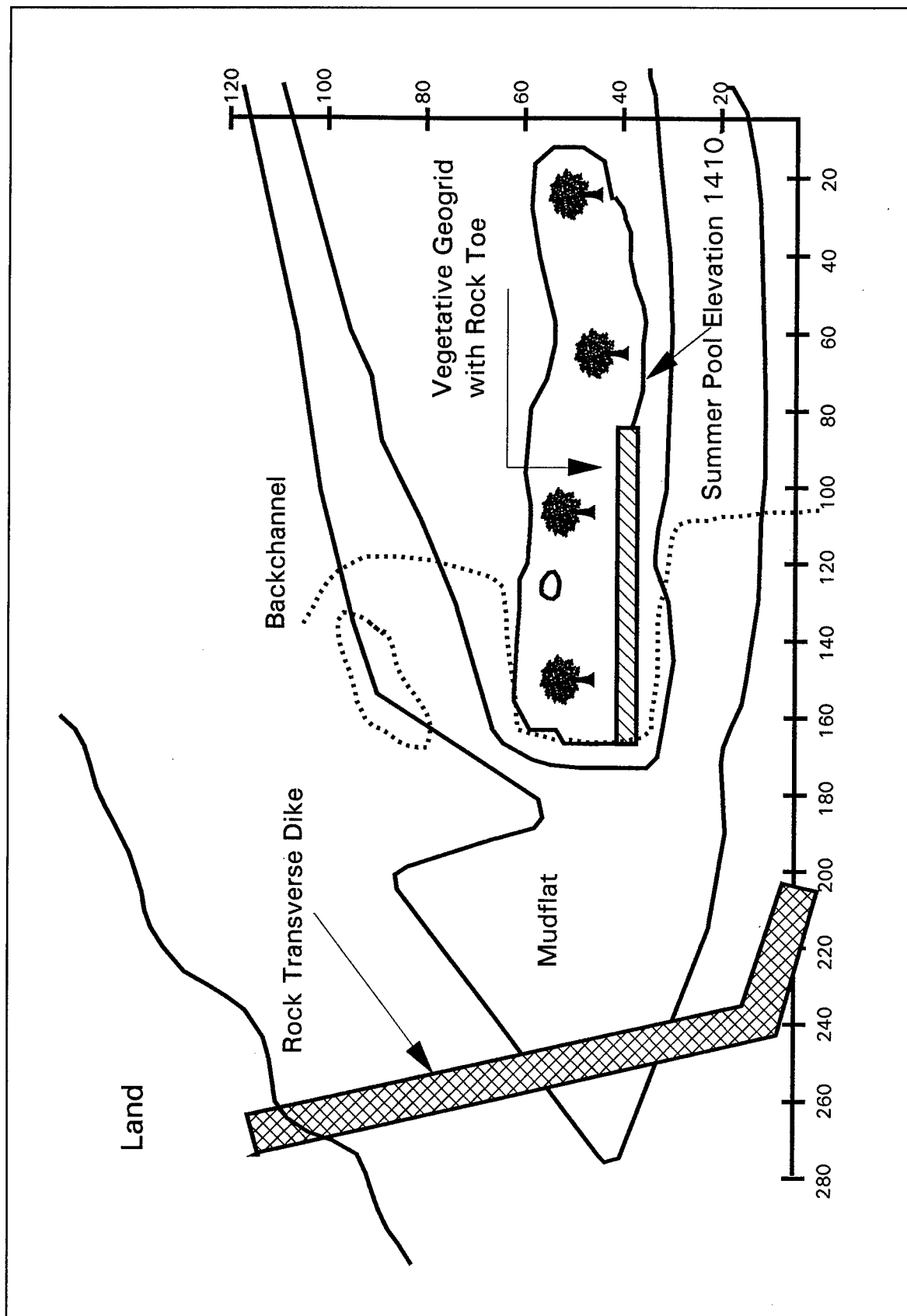


Figure 29. Plan view of transverse dike and vegetation geogrid location

same elevation height as where the woody vegetation presently occurs on the island. The dike would be placed at least 30 to 60 ft lakeward of the escarpment and would probably be at least 3 to 5 ft high. Emergent aquatic vegetation would consist of such species as bulrush (*Scirpus* spp.), rush (*Juncus* spp.), and sedges (*Carex* spp.). Woody vegetation would consist of such species as sandbar willow (*Salix interior*), black willow, buttonbush (*Cephalanthus occidentalis*), and redosier dogwood (*Cornus stolonifera*). All of the above emergent aquatic species would be planted as rooted sprigs and the woody species as rooted cuttings. Planting of woody vegetation should occur during the dormant season just prior to pool raise. Emergent aquatic vegetation could be planted in the growing season, but should still preferably be planted just prior to pool raise.

For the undercut bank on the main part of the island (Figure 24), the following protection is recommended. All shrubs and trees at the edge of the escarpment should be protected, if possible. The slope lakeward of the escarpment should be reworked with a vegetative geogrid and rock toe. The rock toe should be installed from elevation 1,406 to about 1,408 ft msl. A geotextile filter fabric should be placed under the rock. Above elevation 1,408, the vegetative geogrid will be installed. The vegetative geogrid is described below.

A vegetative geogrid consisting of successive walls of two or more lifts of fabric reinforcement should be used. In between the lifts should be placed 5- to 10-ft long live willow whips. This system is described by Miller (1992) and was used successfully on Acid Brook in New Jersey by Inter-Fluve, Inc. The design, according to Miller, is based on a dual fabric system modeled after synthetic fabric retaining walls used by engineers for road embankments and bridge abutments. Two layers of coconut fiber-based fabric provide both structural strength and resistance to piping of fine material. This prevention of piping is needed at the above site because of the erosive nature of the soils. In the Acid Brook example cited above, DeKoWe 700, a strong, woven coir fabric sold by Belton Industries, was used as an outer layer to provide structural support. The outer layer of coconut fabric may be replaced with a plastic geotextile, such as Tensar, for additional strength. North American Green C125, a loose coconut fiber blanket held together by synthetic mesh netting, was used as an interior layer to prevent piping of fine clays, silts, and sands.

Miller (1992) describes building the lifts of fabric-reinforcement as follows:

“To build the streambanks, we would first lay down a layer of each fabric in the appropriate location. We’d place fill material, compact it, and wrap the exposed fabric over the face of the fill. The fabric would be keyed back under the next layer with wooden stakes. We’d progress upwards from layer to layer, whether the slopes were vertical or at a 3:1 slope.”

This type of system was seen after installation on the Upper Truckee River, near South Lake Tahoe. There, Mr. Matt Kiese of Interfluve described

building the lifts with the use of long angle iron forms. The angle irons were 8 ft long and were fashioned to form a frame into which plywood boards were inserted. Then, the forms were wrapped with two fabrics similar to those described above and soil dumped into the forms and compacted. The fabrics were wrapped back over the soil and the forms removed. Willow whips were laid on top of each lift, and then the next lift was prepared. The installation at the Upper Truckee was no more than 5 ft tall and 123 ft long. At the above site, only a couple of lifts 1 ft each would be needed. Care must be taken to transition each end of the fabric-reinforced wall with some kind of semihard to hard material. For instance, one may either tie into existing vegetation, such as trees, or create hard ends by placing rock and forming refusals. Also, it is important to prevent scour at the bottom lift and to provide a good footing by creating a ditch and filling it with cobble or rock. The first lift is placed on top of the cobble ditch. The ditch at the Upper Truckee River site was about 2 ft wide by 2 ft deep.

Costs for the structure used on the Upper Truckee River were given to the authors by the California State Parks and appear below. These costs may only serve as a guide since costs are rather area specific and depend upon local prevailing wage rates and other prevailing prices, such as rental of earth-moving equipment, etc.

Costs for one 12-in.-high lift totaled \$28.51 per linear foot. If the design called for two lifts, this cost would be doubled. Costs included in the \$28.52 figure are denoted below:

Filter fence	\$ 3.47/linear foot
Labor	16.62
Equipment rental	3.96
Materials	4.46
Total =	\$28.51/linear foot

Savings may result in labor since California prevailing union wage rates may be higher than those in West Virginia.

Personnel and time for the above structure included the following:

- 1 foreman/equipment operator
- 1 equipment operator
- 2 laborers
- 1 supervisor/project manager

It took the above crew 3 days to complete a structure that was 123 ft long by about 6 ft high.

46SU22

This is a Fort Ancient village site located at elevation 1,441 ft AMSL. The site has Late Prehistoric, Middle Woodland, and Late Archaic temporal components and Bluestone and Savannah River cultural components. The site was tested by the University of Akron in 1979 producing radiocarbon dates ranging from A.D. 1410 \pm 50 to A.D. 1450 \pm 75. Artifacts include 192 prehistoric pottery sherds, worked antler, worked turtle shell, 1 bone awl, 1 perforated shell bead, 1 nutting stone, 1 hammerstone, 1 triangular projectile point, 1 human tooth, 3 human femur fragments, and Lamoka and Armstrong points. The site had been taken out of agricultural cultivation in 1993. At the time of the WES team visit, the site area was again being cultivated in violation of the wishes of the District archaeologist.

Geomorphic assessment

Situated on a relatively high terrace of the New River Valley, Site 46SU22 is presently experiencing net deposition and burial of the archaeological record. The site appears to be on a broad alluvial surface approximately 25 ft above the level of the prereservoir floodplain in Crumps Bottom (Figures 30 and 31). Crumps Bottom represents one of the few locations in the deeply entrenched New River Valley where the valley is wide enough to contain an alluvial terrace. Since alluvial terraces are favored locations for both prehistoric and historic occupation in any alluvial valley, the Crumps Bottom terraces are particularly important to cultural resources management in the area.

Soil probing of the surface of Crumps Bottom in the vicinity of Site 46SU22 revealed an upper unit of highly disturbed (by modern cultivation) silty sand underlain by dense brownish-red sand. The density and color of the lower sand unit suggest that this unit is of some antiquity, probably at least several thousand years old. During the flood of January-February 1996, the site was inundated by several tens of feet of water, and some sedimentation occurred on the site during recession of the flood. Sedimentation was measured at three points near the site, as illustrated in Appendix A. At point "A," a low shelf above the floodplain below the high terrace, and next to the reservoir shoreline, 8 cm of sedimentation occurred in February 1996. At point "B," on the edge of the high terrace and the reservoir side of the site, approximately 3 cm of sedimentation occurred. At point "C," on the southwestern edge of the site, about 1 cm of sediment was deposited.

The principal process of negative site impact at Site 46SU22 is disturbance of the soil by cultivation. Annual cycles of plowing, planting, cultivation, and harvesting of corn in Crumps Bottom is having a deleterious effect on the integrity of the site. Artifacts of the archaeological record are being broken, crushed, exposed, unofficially collected, and geochemically altered as a result of corn cultivation on the site. Sedimentation from floods has the positive



Figure 30. WES team at 46SU22 with Dr. Robert Maslowski (photo by Hugh Taylor)



Figure 31. View of fertile bottomlands at 46SU22

impact of burial and partial protection, but is not sufficient to protect the site from the damage of cultivation. One possible solution that would partially protect the site while allowing the production of corn is the practice of no-till cultivation of corn. In the practice of no-till cultivation, plowing to prepare the seedbed is not conducted, and plant residues are left on the surface. Seeds are usually planted with a drill. No-till cultivation results in far less soil disturbance and fewer tractor trips across the site surface.

Protection recommendations

The site is located on an old river terrace with ridges and swales in the terrace (Figures 30 and 31). The site is presently being cultivated for corn and has bottomland hardwood forests occurring at the edges of the fields. The corn fields in the area are estimated to be about 300 acres in size. The bottomland hardwood forests consist of various species including black willow, sugar maple, red maple, and others. The bottomland hardwood forests and the wetlands in the area were abundant with deer, turkey, squirrel, and waterfowl, all of which were observed in the area. The field containing the site had several centimeters of sediment deposited on it from a near record flood that occurred in January 1995. There was little residual corn grain left on the corn husks in this field at the time of observation.

The village site is estimated to cover about 5 acres and is presently being impacted by plowing used for the cultivation of corn. This plowing may intersect and disrupt soil horizons containing cultural artifacts, thus destroying both the artifact and the soil matrix that indicates much of the history surrounding the artifact.

The site could be protected from further impacts by employing one or both of the following management alternatives:

- a.* The area of the field containing the village could be isolated from further cultivation by planting hardwood trees at the edges of the site. The village site itself could be converted to a mixture of upland grasses and forbs suitable for food and cover for various wildlife species. This would provide additional diversity to the area, part of which is being used as wetlands for waterfowl management.
- b.* The whole area could still be used for corn production, but impacts could be substantially reduced or eliminated if a "no-till" method of corn cultivation were implemented. This is a method where plowing is eliminated. Seeds are planted with a drill, and residual corn stalks at the end of the season are merely allowed to decay in the field and serve as mulch for the next growing season. This method has been used extensively in Illinois and other midwestern States.

46SU20

This is a village site located at elevation 1,428 ft AMSL with Late Prehistoric, Early Woodland and Early Archaic temporal components and Bluestone, Radford, and Savannah River Cultural components. Solecki's (1949) surface collection produced 930 prehistoric pottery sherds, 1 flat celt, 1 ferruginous ball concentration, 1 bone bead, miscellaneous worked bone fragments, and many projectile points and point fragments. Solecki (1949) excavated two test trenches and one test pit that produced numerous ceramic potsherds, flint flakes, projectile points and point fragments, 1 tubular clay pipestem, 1 carved turtle shell cup, numerous worked animal bone fragments, and human toe bones. The site had been taken out of agricultural cultivation in 1993. At the time of the WES team visit, the site area was again being cultivated in violation of the wishes of the District archaeologist.

Geomorphic assessment

The landscape setting of Site 46SU20 is very similar to 46SU23 with the exception that the amount of sedimentation that is apparently occurring on the site during falling floods is less. The site is also situated on the high terrace of Crumps Bottoms (Figures 32 and 33). Subsurface examination of soils at the site revealed soil strata similar to Site 46SU22. Corn cultivation is impacting Site 46SU20 more profoundly than at 46SU22 because of the reduced level of sedimentation that would serve to partially protect the site. Reduction of the impact of traditional methods of corn cultivation at Site 46SU20 is particularly urgent.

Protection recommendations

The site can be generally described in the same way as Site 46SU22; that is, it contains largely the same vegetative component of bottomland woodlands surrounding a cornfield, all on an old river terrace. The only observed differences were that the site was not covered with as much sediment and there was more residual corn grain left in the field after harvest. The site could be protected in the same way as Site 46SU22.

Engineering approaches for Bluestone sites

The soil at all of these sites can be generally described as Kanawha fine sandy loam. It is level and well drained. It is found on low terraces and high floodplains that are subject to rare flooding. Typically, the surface layer is a dark brown fine sandy loam about 7 in. thick. The subsoil is approximately 43 in. thick. The upper 5 in. of this subsoil is brown fine sandy loam, and the lower 40 in. is reddish brown loam and fine sandy loam. The substratum



Figure 32. View of Site 46SU20: Looking toward New River (photo by Lawson Smith)



Figure 33. View of narrow valley at Site 46SU20 (photo by Lawson Smith)

is yellowish red sandy loam to a depth of 60 in. or more. The available water capacity of this Kanawha soil is high. Permeability is moderate in the subsoil. Runoff is slow, and natural fertility is high. The depth to bedrock is greater than 60 in.

The Fort Ancient village portion of 46SU3 is inundated during summer pool and exposed as a mud flat adjacent to the heavily vegetated island during winter pool. The combination of a structural fix (transverse dike) and revegetation after sediment has accumulated behind the dike, as presented by Smith and Allen above, is strongly recommended. The two Crumps Bottom sites (46SU22 and 46SU20) appeared to have 1 to 3 in. of recent soil deposition due to the January high water. The no-till agriculture solution, as discussed by Smith and Allen above, is also recommended.

Table 2 shows the recommended protection alternatives for the Bluestone sites.

Table 2 Potential Erosion Control Methods for Bluestone Reservoir Archaeological Sites in the Drawdown Zone				
Site	Predominant Erosion Mechanism	Additional Design Concerns	Site Protection Method	Comments/ Recommendations
Bluestone, West Virginia 46SU3	Wave, overtopping, drawdown	Current, hydropower potential	Transverse dike, Geoweb and vegetation	Crumps Bottom, Kanawha soil
Bluestone, West Virginia 46SU20	Rain impact and sheet erosion	Cornfield, hydropower potential	N/A, change cultivation	Determine site priority; Kanawha soil
Bluestone, West Virginia 46SU22	Rain impact and sheet erosion	Cornfield, hydropower potential	N/A, change cultivation	Determine site priority; Kanawha soil

Management Summary

46SU3 (Barker Site)

The island should be tested to determine if there are intact cultural deposits related to the two Fort Ancient village components. If intact cultural deposits are present, this portion of the site should be protected for future research efforts. Hollis Allen has recommended that all shrubs and trees at the edge of the escarpment be protected, if possible. The slope lakeward of the escarpment should be reworked with a vegetative geogrid and rock toe. The rock toe should be installed from elevation 1,406 to about 1,408 ft msl. A geotextile filter fabric should be placed under the rock. Above elevation 1,408, the vegetative geogrid will be installed.

The main portion of the site as delineated by Adovasio's testing should receive both site protection and limited data recovery. The WES team members have recommended the construction of a rock structure (such as a riprap groin or dike) upstream of the site that would divert flows away from the site and trap sediment behind it on the eroded shelf. This is probably the best long-term structural solution. Hollis Allen also recommends that after sediments build up and reach a point of equilibrium (probably about 1 year after construction), the area of deposition should be planted with wetland vegetation. This would consist of both emergent aquatic vegetation in the deeper water zones (5 to 10 in. of water at summer pool elevation) to shrubby woody vegetation in the shallow water zones (0 to 5 in. of water at summer pool elevation).

The limited data recovery would consist of a grid of test units on the island, a controlled surface collection on the main portion of the site, and excavation units in any area that would actually be disturbed by the construction of the rock dike or the protection measures described by Allen for the island.

46SU22

The site should be nominated to the National Register, and a monitoring plan should be prepared in the near future. Deep plowing on this site relating to the cultivation of corn by Bluestone Farms should be stopped. No-till cultivation could be tried for a few years to determine what effect it was having on the site. These authors recommend that alfalfa or some other grass crop be tried that would not involve any subsurface disturbance. The area of the field containing the village could be isolated from further cultivation by planting hardwood trees at the edges of the site. The village site itself could be converted to a mixture of upland grasses and forbs suitable for food and cover for various wildlife species.

46SU20

Treatment of this site is similar to that proposed for 46SU22. The National Register nomination should be prepared possibly as a multiple property nomination including the other prehistoric village sites in Crumps Bottom. Lawson Smith has noted that corn cultivation is impacting Site 46SU20 more profoundly than at 46SU23 because of the reduced level of sedimentation that would serve to partially protect the site. Reduction of the impact of traditional methods of corn cultivation at Site 46SU20 is particularly urgent. No till cultivation, grass crops with no plowing, etc., should be explored. The preparation and implementation of a monitoring plan is recommended.

10 Case Study 3: Allegheny Reservoir, Pennsylvania and New York

Management Problem

Allegheny Reservoir was formed by the construction of the Kinzua Dam authorized in 1936 and 1938. The reservoir is more often referred to by the residents of northwestern Pennsylvania as Kinzua (Figure 34). The Kinzua concrete dam and earth embankment, with four 24- by 45-ft crest gates, extends an overall length of 1,877 ft. The outlet works through the concrete section include eight 5-ft 8-in. discharge sluices and two 15-ft-diam hydro-electric penstocks. The reservoir length at summer pool is 24.2 miles. Pertinent elevations include the following:

Normal summer high pool elevation = 1,328 ft

Normal winter pool elevation = 1,292 ft

Highest reservoir pool elevation = 1,362 ft

Maximum pool elevation = 1,365 ft

Most severely impacted elevation = 1,325 to 1,345 ft due to drawdown requirements

Elevation of pool during visit = 1,306 ft

Allegheny Reservoir is normally operated with a fluctuation of 28 ft between summer (1,328 ft msl) and winter (1,300 ft msl) pool levels. The maximum pool level of design is 1,365 ft msl, with an actual maximum level of 1,362.17 ft msl achieved in June 1972. The conservation pool is designed for 1,240 ft msl, but the low pool of record was 1,282 ft msl. The reservoir is typically frozen in winter during low pool levels. Spring thaws usually occur in late March or April. During the WES team's reconnaissance of 12-14 March 1996, most of Allegheny Reservoir was covered in ice to a depth of 8 to 10 in. (Figure 35).

Allegheny Reservoir was first visited on August 3, 1995, during the course of the initial field visits for the drawdown work unit. A summary description of the current management practices observed there appears in Dunn

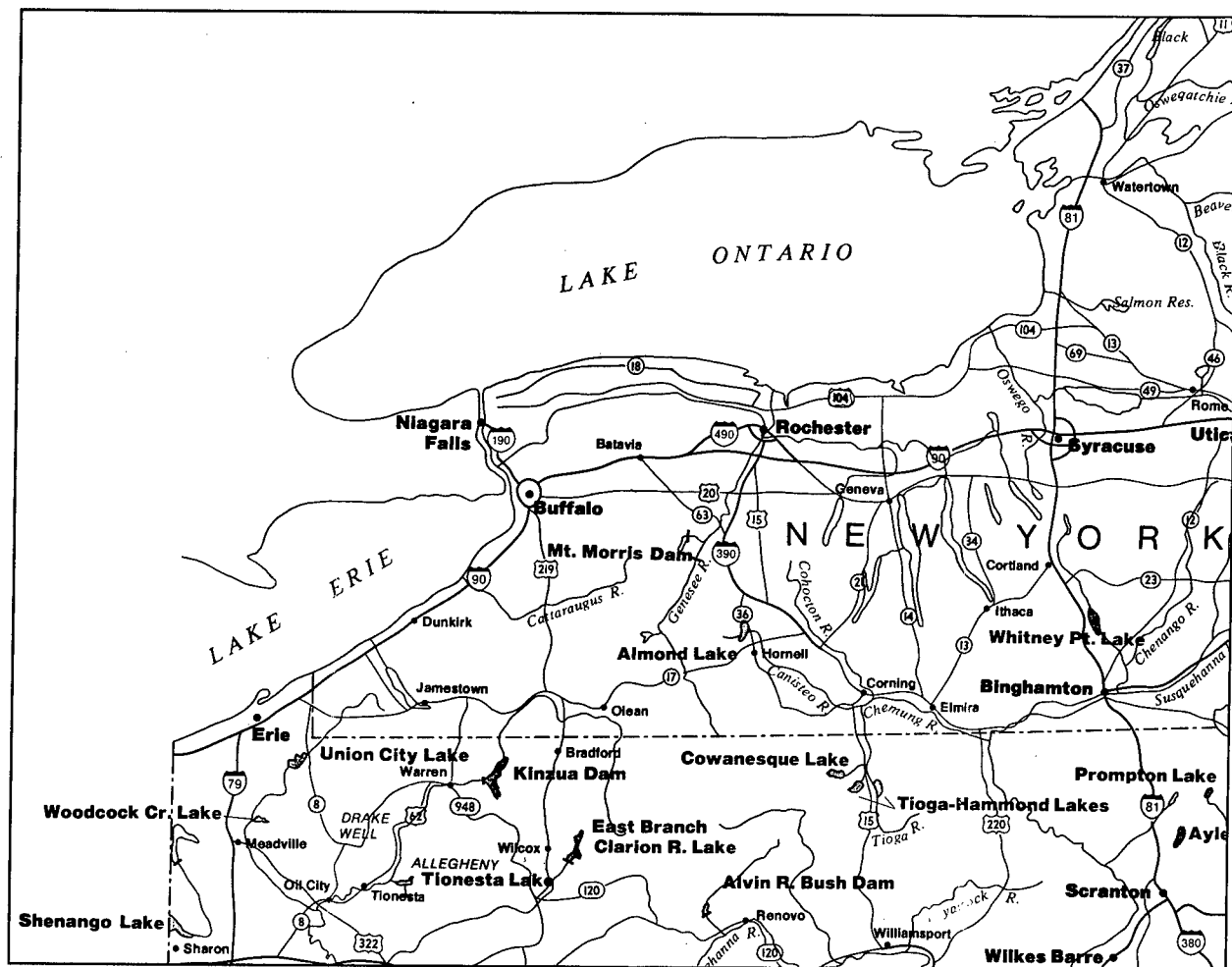


Figure 34. Allegheny Reservoir (Kinzua): Project vicinity map

(1996:57). Because the Pittsburgh District has no professional archaeologist on staff at this time, Ms. Kathleen Anderson serves as the cultural resource coordinator for Pittsburgh District's Operations Division. A Historic Properties Management Plan is projected for completion in the near future.

On 12 March 1996, the WES team met onsite with personnel representing the Corps of Engineers' Pittsburgh District, the U.S. Forest Service's Allegheny National Forest, the Seneca Indian Nation, and archaeological consultant Dr. Stan Lantz, a research associate with the Carnegie Museum, Pittsburgh, PA. Mr. John Zavinski, a paraprofessional archaeologist with numerous archaeological publications, who is now a member of Congressman William Klinger's staff, also attended the initial meeting. After the objectives of the trip were discussed, all personnel visited those drawdown sites judged to be significant cultural resources.

Since 1965, the Carnegie Museum, under contract to the National Park Service, has conducted almost continuous research in the area of the Allegheny Reservoir. Archaeological salvage excavations of sites now



Figure 35. Frozen reservoir at Willow Bay near Riverview/Corydon Cemetery: Lawson Smith standing on lower bench between outwash terrace and underlying Paleozoic bedrock

within the conservation pool were conducted by the Carnegie Museum during each field season from 1968 through 1974. Much of this work was performed by Dr. Stan Lantz who accompanied the WES team during the course of the follow-up visit.

Only portions of the reservoir drawdown zone have been intensively surveyed. Sample surveys of the drawdown zone were performed in the 1980s, and opportunistic small surveys are presently conducted by U.S. Forest Service archaeologists during annual drawdowns. Because it is surrounded by the Allegheny National Forest in Pennsylvania, cultural resource management of the land surrounding the lake is the responsibility of the U.S. Forest Service. Land around the reservoir in the State of New York constitutes part of the Seneca Nation reservation.

The land in Pennsylvania above summer pool elevation 1,328 ft has been deeded to the Forest Service, and the Corps of Engineers has only an easement to operate the reservoir for flood storage. Only below elevation 1,328 ft and at a few areas around the lake (e.g., Onoville Marina) are lands held in fee status by the Corps of Engineers. The Corps and the Forest Service are in disagreement over which agency has the responsibility for mitigation of adverse effects to historic properties as a result of annual winter drawdowns

below elevation 1,328 ft. A discussion of this problem is presented in the management summary of the case study.

The Allegheny Reservoir was selected as a case study because it contains a rich archaeological record that is being directly impacted by the normal operation of the reservoir. The Hopewell Mound site at Sugar Run, the historic Riverview/Corydon cemetery where the historic Seneca chief, Cornplanter, is buried, several proto-Iroquois villages, and a variety of earlier prehistoric sites are all being impacted by the annual drawdown and the periodic storage of floodwaters. The descriptions of the sites visited by the WES team have been provided by Mr. Richard Kandare and Mr. Robert Scott, archaeologists with the Allegheny National Forest.

The normal operation of all reservoirs significantly impacts the cultural resources that occur within and immediately adjacent to the zone of pool fluctuation. Processes of erosion, deposition, and geochemical alteration may substantially impact or destroy the resource in only a few years of reservoir operation. Where cultural resources are clustered in a major river valley, such as the Allegheny of western Pennsylvania and New York, the impact of the fluctuation of the reservoir can be devastating to cultural resources. In the 30-year period since the creation of Allegheny Reservoir in 1966, erosion of the shoreline has dramatically destroyed most of the known cultural record that occurred within the prism of pool fluctuation. Indeed, little evidence of the cultural record documented during preimpoundment surveys even exists today.

Deeply entrenched into Pennsylvanian (Paleozoic) sedimentary rocks (primarily sandstone and shale), the valley of the Allegheny River has experienced a geological history influenced by both the regional structural evolution of the area (over many millions of years) and Pleistocene glaciation (over tens of thousands of years). The steep-sided valley is contrasted with a valley floor that has been carved by glacial meltwater as well as interglacial flows of different directions and magnitudes. Geological materials that make up the shoreline of the Allegheny Reservoir include in situ well-indurated sedimentary rocks along steep valley walls, colluvial accumulations of local rock on moderate slopes, alluvial terraces created by glacial outwash flows and interglacial stream valley development, and floodplain alluvium in the upper reach of the reservoir. Soils developed on rock slopes are typically thin and readily eroded. The alluvial deposits that occur in the zone of fluctuation are particularly susceptible to the erosive processes of flows, currents, waves, and ice. During the WES reconnaissance, four site areas were examined, including the Riverview/Corydon Cemetery, the Nelse Run site, the Red Bridge sites, and the Steamburg sites. A brief description of the geomorphic setting and relevant geomorphic processes impacting the sites is presented below. Appendix A shows the geomorphology data sheets and original sketches for these sites.

Sugar Run Village and Mound (36WA2)

This major site consists of Middle and Late Woodland prehistoric villages with a clear Hopewell component (burial mound). The size of the site is estimated at 200 by 600 ft. The site was partially excavated by the Pennsylvania Historical Commission Society in 1941. Mr. Edmund Carpenter and his assistant, Mr. Wesley Bliss, excavated the Mound and a small trench in the lower village. Numerous burials with grave goods were encountered. The site lies at elevation 1,260 ft and is generally not exposed by the normal winter drawdown (down to 1,300 ft). A major drawdown does expose this extremely significant site. The site was not exposed at the time of the WES team visit in March 1996. The fact that the site is normally not subject to the adverse effects of wave attack and vandalism may ensure its long-term preservation. Further discussion of the long-term management issues regarding this site appears in the summary section of the case study.

Riverview/Corydon Cemetery

Located on a high bluff above the reservoir and surrounded by lands owned by the Seneca Nation, this beautiful and historic cemetery holds the remains of many Seneca, including the Revolutionary War Chief Cornplanter (Figures 36 and 37). His remains were reinterred in 1964 from the original "Cornplanter Grant," which was inundated at the time the reservoir was created. Cornplanter was granted this land and two other tracts by the Pennsylvania Legislature in 1791 in return for his aid to the American cause during the Revolutionary War.

The historic town of Corydon's cemetery was also relocated to this location at the time the reservoir was created. The National Register status of the combined Riverview/Corydon cemetery has not been formally determined since it is privately owned. It appears to be potentially eligible under Criteria A and B (association with a historically important event and person, respectively) because of its association with the Seneca Chief Cornplanter, a major figure both for Pennsylvania and American history during the Revolutionary War period.

Wave erosion is threatening the historic Riverview-Corydon cemetery. In a 1995 status report to the Corps, Forest Service archaeologist Robert Scott reported the following:

"Wave action, and the erosion it produces, has been responsible for another concern on the reservoir. The west facing slope to the Riverview/Corydon cemetery has eroded significantly since 1964. The surface and sub-surface material in this area was deposited during glacial periods. It is a combination of sands, gravels, and sandstone conglomerate stone deposited by glacial outwash. This sort of geology does not lend itself to stability under normal conditions. Wave action from fluctuating water levels, spring storms,



Figure 36. Cornplanter Memorial at Riverview/Corydon Cemetery - Allegheny Reservoir



Figure 37. Riverview/Corydon Cemetery high above Allegheny Reservoir

and the associated high water as well as recreation use have caused severe erosion problems.”

A proposed stabilization project in 1987 submitted to the Pittsburgh District to protect the Riverview-Corydon cemetery was not implemented due to the prohibitive estimated cost (Appendix B). At this time, the erosion problem remains unsolved. There is continuing disagreement between the Pittsburgh District and the U.S. Forest Service regarding the legal responsibility for protecting the threatened cemetery. The normal operation of the reservoir by the Corps is causing the erosion problem. However, the land where the erosion is occurring is owned by the Forest Service. Further discussion of this management dilemma appears in the management summary section of the case study.

Geomorphic assessment

Situated on a high glacial outwash terrace above the confluence of Willow Creek and the Allegheny River, the site is experiencing rapid erosion on its south- and west-facing sides (Figures 38-42). The steep slope of the shoreface, a long fetch for wave generation, and the occurrence of relatively

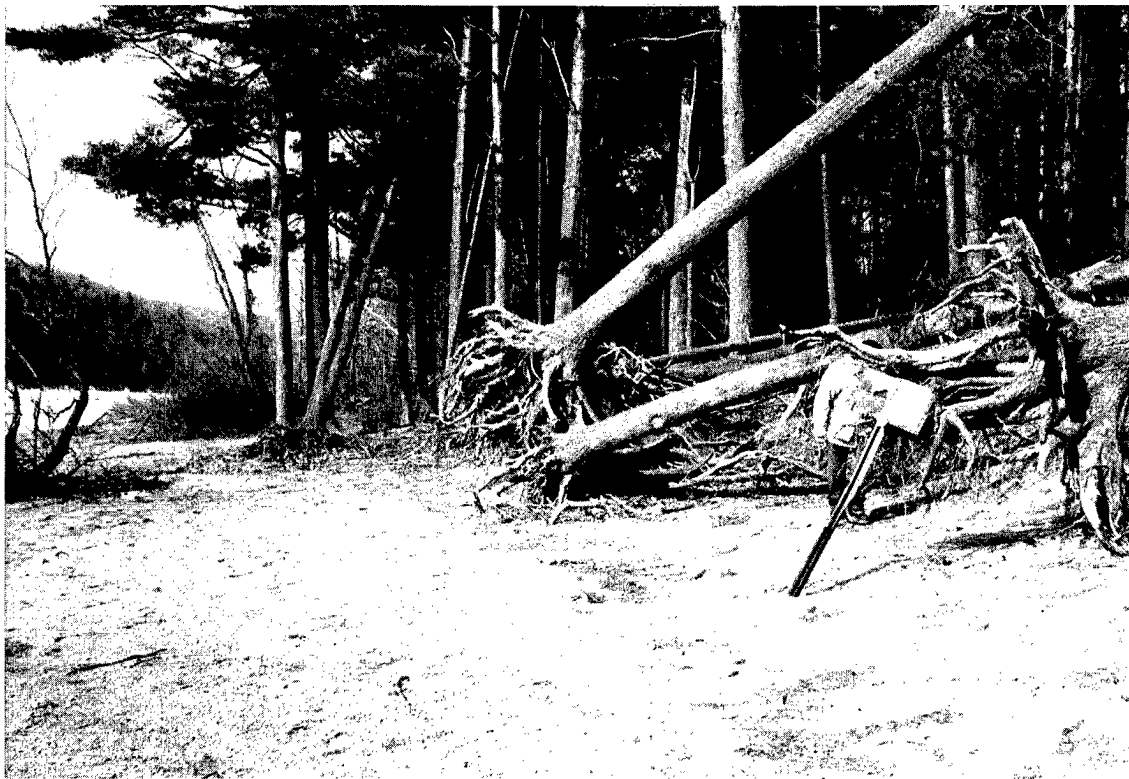


Figure 38. Eroding shoreline - South side of Riverview/Corydon Cemetery near base of bluff



Figure 39. Eroding shoreline at Riverview/Corydon Cemetery - Southwest face



Figure 40. Erosion along west face of bluff below Riverview/Corydon Cemetery



Figure 41. Calcium carbonate conglomerate at Riverview/Corydon Cemetery

erodible materials at the site contribute to the activity of a variety of geomorphic processes that are removing the cultural record at the site.

The cemetery is underlain by glacial outwash deposits of sand, cobbles, and boulders. Interestingly, the outwash deposits are being cemented by calcium carbonate precipitation upon exposure to the near-surface fluctuation of soil moisture to form a conglomeratic ledge near the top of the site (Figures 36 and 37). Carbonates are also being precipitated in a sand facies beneath the conglomerate to form a weakly indurated sandstone. These materials fail in mass upon removal of basal materials at the summer pool level. Destructive geomorphic processes active at the site include wave breaking and swashing, ice gouging and battering, overland flow, and soil falls and slides from the toe of the shoreface to the top, respectively. A berm in unconsolidated gravely sand occurs about 6 ft above the elevation of the summer pool at the steepest face of the site. This berm may represent a wave-cut bench produced during a high (above summer pool) flow event (Figure 37). A lower bench was observed at an elevation approximately 10 ft below the summer pool level on the shoreface. Comprised of local sedimentary rock, this bench may represent the contact between the base of the outwash terrace and the underlying Paleozoic "bedrock" (Figure 35).

On the south-facing escarpment of the site, the profile differs from the west-facing escarpment (Appendix A). The thickness of the outwash deposit

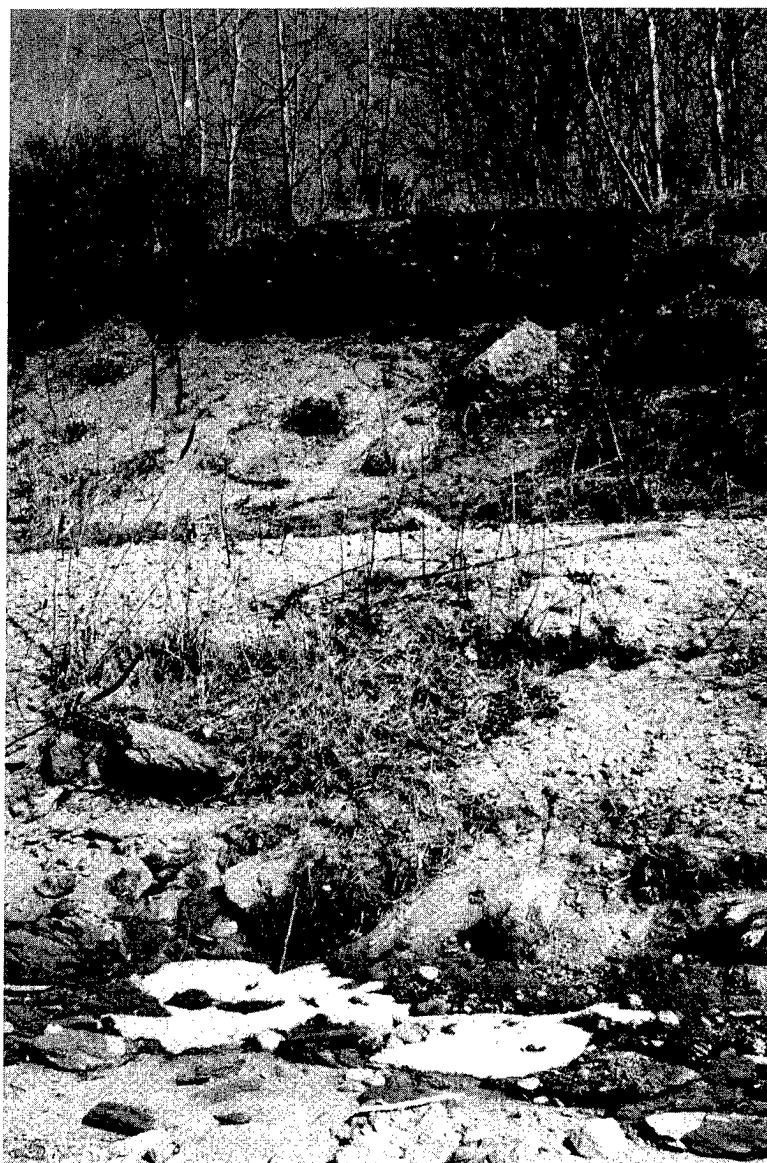


Figure 42. West face of eroding bluff at Riverview/Corydon Cemetery: Conglomeratic ledge and wave-cut bench marking height of summer pool

is greatly diminished or absent, and the slope has developed in the weathered Paleozoic sedimentary rocks. The most destructive geomorphic processes active at the south-facing shoreline are wave processes.

Arresting erosion at the Riverview/Corydon Cemetery site will be a challenge. A scheme that combines both hard structural components (such as placed stone or gabions) around the toe of the site and softer, possibly vegetative components above the level of the summer pool may have the best chance of success. As a previous engineering estimate prepared in 1987 revealed, the cost of stopping erosion at the site will be substantial (Appendix B).

Bioengineering approaches

The team observed the southern end of the cemetery that was being threatened by erosion from reservoir operations. A number of erosion-causing processes are at work at this site. Chief among them are wind-driven waves from the south that undercut the bank causing mass failures. Soils are extremely fragile consisting of noncohesive sandy silts and sandy gravels. Extreme fluctuations of reservoir pool levels between winter and summer pools (1,300 to 1,328 ft msl) and flood pools that occur infrequently (up to 1,362.17) cause undercutting of the bank at various elevations up and down the slope. Freeze-thaw action on the slope also contributes to the mass failures.

In places, clumps of willow were starting to colonize on the slope at about the same elevation as summer pool, particularly on the southwest side of the site. These are helping to attenuate some wave energy and are causing some siltation buildup around them.

Because of the many complex erosion processes described above, this site will be difficult to protect. A Corps of Engineers (Pittsburgh District) study in 1987 offered several alternatives, all consisting of a rock-riprapped slope (Appendix B). Costs for these alternatives were expensive in 1987, ranging from \$586,000 to \$784,000. They were apparently discarded because no more graves at the site were being exposed and because of the expense. Any one of these alternatives should correct the erosion. Without treatment, the site will continue to erode, particularly with repeated high-water events. Continued and unchecked erosion will make the situation worse over time and will be even more expensive to correct in the future.

Even though complete control of erosion can probably only be achieved with a structural fix such as riprap, erosion can possibly be slowed with a much less expensive alternative. This would include augmenting the existing willow colonies with additional willow so as to still wave action and prevent undercutting. A willow revetment could be installed just below, at, and above the summer pool elevation. In this method, dormant live willow poles would be inserted vertically into the substrate. These would consist of about 8- to 12-ft-tall and 3- to 6-in.-diam willow at the base. They could be inserted by use of perhaps an auger or a stinger. The latter is a long and solid metal probe mounted on a backhoe that is pushed into the ground to make a pilot hole. Then, a metal cap is placed over the willow pole and the stinger inserted into the cap. The willow with cap are then pushed into the pilot hole. Rock can be piled below and around the willow poles to ensure scour protection, or rock can be placed first and the stinger pushed between the rocks and then the willow inserted. This method has been successfully used on American Falls Reservoir in Idaho by the Natural Resources Conservation Service and the Bureau of Reclamation (Hoag, Short, and Green 1993). The presently occurring willow zone of protection could be substantially expanded by use of this method of artificially inducing willow lower into the drawdown zone.

Costs of the above willow post method can vary depending on how far willow has to be transported to the site and the price of labor. However, as an example, on Illinois streams where this method has been used by the Illinois Water Survey, costs for a 20-ft-wide swath of willow with willow along four rows spaced about 3 ft apart cost \$15.19 per linear foot. The cost includes a rock toe made out of 20 tons of 10-in. rock placed along the first row of willow poles (Roseboom et al. 1995).

Engineering approaches

The soils at this site are Chenango gravelly loam, 3 to 8 percent slopes. This is a gently sloping, very deep, well-drained soil on stream terraces. Typically, the surface layer is dark brown gravelly loam about 7 in. thick. The subsoil extends to a depth of 31 in. It is yellowish brown gravelly loam to a depth of 19 in. and yellowish brown very gravelly loam to a depth of 31 in. The substratum is brown, extremely gravelly loamy sand to a depth of 80 in. or more. Permeability in this Chenango soil is moderate or moderately rapid in the surface layer and the subsoil and rapid in the substratum. The soil is very strongly acid to moderately acid in the subsoil and strongly acid to neutral in the substratum. Erosion is a moderate hazard. The soil is suited to trees. The potential habitat for wetland plants is very poor.

A review of the Pittsburgh Engineering Consultants, Inc., 1987 proposed Riverview/Corydon Cemetery erosion protection plan (Appendix B) raised the following concerns:

- a. Page 2, paragraph 1: The consequences of the assumption that “loss below elevation 1,318 or above elevation 1,350 is negligible” may be severe erosion in the event of reservoir elevation above about 1,354 and the design waves occur. The probability of this event should be reconsidered in selecting any design.
- b. In evaluating the proposed riprap design, assumed average weights of 140 and 160 pcf for the Penn DOT graduation R-7 indicated the potentially undersized riprap. The weight of rock should be checked for the 3.5-ft design wave.

In general, those future design alternatives that include a flat bench will help trip waves to a depth of about 4 ft over the bench. For reservoir elevations above 1,354, the runoff of the 3.5-ft wave height will result in similar erosion problems as seen in the past high water events.

Red Bridge Sites (03-338A,B and 03-339)

Site 338A is a prehistoric site in the upper section of Kinzua, 45 m from the abandoned road bridge at the 1,322 elevation. An intermittent creek flows

into the Kinzua from the south. The site lays at the confluence of this unnamed creek and the Kinzua. During walk-over examination of the area in 1992, a large quantity of Onondaga chert debitage was discovered. Repeated surface examinations over several days revealed a partial Lamoka-type projectile point, one complete Lamoka-type knife, one Brewerton-type point, and surface charcoal. Subsurface examinations revealed heavy charcoal deposits between 0 and 30 cm. No lithics were observed in subsurface tests. This site is known to be located on a seasonal basis and is also impacted by wave action from the reservoir during fluctuating water levels. Subsequent seasonal examinations of the area in 1993 and 1994 revealed small quantities of chipping debris, but no additional tools were found. The remaining subsoil on the site has been eroded significantly, and it is suspected that the site will disappear completely with the next 5 years.

Site 338B is another prehistoric Archaic site located in the upper Kinzua, 90 m west of the abandoned highway section at the 1,322 ft elevation. Surface artifacts consist of Onondaga chert debitage. No subsurface testing was accomplished at this location. The site is exposed during winter pool water levels. This prehistoric site may be associated with 338A and Mc 18-20.

Site 339 is a prehistoric site located 60 m southwest of Site 338A and 130 m due south of the Kinzua stream channel. This site is exposed during winter pool water levels and is at the 1,320 elevation. The surface artifacts, consisting of Onondaga chert debitage and a curved scraper of Flint Ridge yellow brown Chalcedony, were found laying immediately next to a narrow rail grade.

Geomorphic assessment

The "Red Bridge" sites may represent an example of the type of cultural resources where CRM efforts may be the most productive in the Allegheny Reservoir project area (Figures 43 and 44). These sites in the tributary valleys may have experienced the least amount of damage from reservoir fluctuation. Situated in alluvial valleys that have aggraded in response to the Allegheny River, the possibility of the existence of buried undiscovered sites in these areas is significant, particularly for older (Archaic) sites.

Red Bridge is approximately 8 miles upstream on Kinzua Creek above its confluence with the Allegheny, at its confluence with the South Branch of Kinzua Creek. The sites are located on the prereservoir floodplains of Kinzua Creek and its south branch. The stratigraphy of the upper several feet of the area consists of fine-grained vertical accretion deposits from the tributaries. The deposits offer little resistance to wave processes when the area is covered by 4 to 8 ft of water during summer pool. Exposed stumps in the area indicate that although some sedimentation does occur at the site, the net is steady erosion, as much as 2 ft. Many previously identified cultural features have been eroded from the area.



Figure 43. View of Red Bridge site area - Allegheny Reservoir



Figure 44. Winter drawdown at Red Bridge site area - Allegheny Reservoir

The consideration of enclosing the area in a "sub-impoundment" for various resource management objectives has promise of providing protection of the area from erosion as well. In fact, the "sub-impoundment" would result in some sedimentation, serving to protect the sites in the area.

Bioengineering approaches

Since these sites are covered by 3 to 5 ft of water during summer pool and include such a broad area, a site protection plan consisting of vegetative cover would be impossible. However, bioengineering treatments could be applied in upper tributaries and at the edges of the summer pool if cultural resources are found in those areas and protection is deemed warranted. If these areas need protection, then treatments such as those discussed next for the Nelse Run area may be plausible.

Nelse Run Site (36MC29)

This prehistoric site was first recorded in 1964 during the Phase 1 survey for the reservoir. The site is located at the mouth of Nelse Run in the northeast corner of Sugar Bay. Preliminary artifact recovery indicates an Adena burial mound of modest size with Woodland artifacts superimposed. Of special interest is the fact that long-term monitoring of the site by amateur and professional archaeologists documents extensive soil removal by erosion due to fluctuating water levels. The site is exposed during the annual winter drawdown.

Geomorphic assessment

Located in a tributary mouth, the Nelse Run Site has been substantially eroded by wave breaking and swash (Figures 45-48). Although sediment is being contributed to the area by Nelse Run, this sediment is being effectively removed during pool fluctuation (transgression and regression). Before the creation of the reservoir, the site was the locus of net sedimentation, possibly serving to bury and preserve the cultural record. There may still be buried components of the cultural record on the site above the summer pool level (in the area covered by trees). Exposed stumps at the site indicate soil erosion of several (2 to 3) feet through most of the shoreface.

The long shallow shoreface and thick alluvial deposits of the Nelse Run site lends it to erosion control by vegetative schemes. Although much of the site has been removed by erosion, the northern (upslope) parts of the site may still have buried components of the cultural record and warrant consideration for protection.



Figure 45. Nelse Run site area: WES team meeting with Corps and Forest Service personnel



Figure 46. Nelse Run site area: Archaeologist Stan Lantz discussing eroded Adena burial mound



Figure 47. Nelse Run site area: Area in trees is recommended for testing



Figure 48. Nelse Run site area: Robert Dunn videotaping onsite meeting with Corps and Forest Service personnel

Bioengineering approaches

This is an area in one of the arms of the reservoir that is high enough in elevation so as to be exposed during winter drawdown. Here, the team observed stones that were once part of a prehistoric grave. The grave was no longer intact and had been robbed of its artifacts. The area contained a small creek, Nelse Run, that drained the watershed. Dr. Stan Lantz maintained that potential sites could be found up and down the creek's watershed and more specifically on the old creek terraces.

Once the summer pool elevation of the reservoir was exceeded, various vegetation types started appearing. The lower elevations slightly below and above elevation 1,328 ft, the summer pool, were covered by a monotypic stand of reed canary grass (*Phalaris arundinacea*). As one proceeded slightly higher in elevation, woody species of shrubs and trees started appearing consisting of such species as yellow birch (*Betula alleghaniensis*) and black cherry (*Prunus serotina*). The reed canary grass was doing a good job of protecting the area from surface scour that could be produced from wave wash when the reservoir is filling and regression as the reservoir recedes in the fall. Reed canary grass also offers good spawning habitat for Northern Pike fish, which occur in the reservoir.

If further protection of this area is considered warranted after additional cultural resource surveys of the terraces are conducted, an assemblage of vegetative species could be planted to provide further cover and surface protection down into the drawdown zone. These would need to be wetland plants that would require some special handling to ensure their survival. This is necessary because of the poor soil conditions in the area, i.e., the top soil has been washed away. Plants that would be appropriate candidates include such species as maidencane (*Panicum hemitomon*), spike rush (*Eleocharis quadrangulata*), and various sedges (*Carex* spp.). Special handling measures may include growing these plants in combination with geotextiles that provide both a growing medium and a means of root anchoring. One technique is a plant roll described by Allen and Klimas (1986). This is an 8- to 10-in.-diam cylinder 6 to 10 ft long made from burlap that encapsulates both soil and rooted sprigs/clumps of wetland plants. Inside the cylinder, one can add slow-release fertilizer to speed plant development. The fertilizer is held in place by the burlap covering and is not lost to the water column. This plant roll is buried in the lake substrate with the aid of a hydraulic jet pump or a shovel. Another technique is described by Knutson, Allen, and Webb (1990) and consists of growing plants in a coconut fiber mat that is 2 in. thick. This mat tends to trap sediment and serve as a root-anchoring device. Plants can be grown in place or pregrown in the mat in a nursery and then transferred to the site by rolling it up on a pole and carried by a couple of people. The edges of the mat are anchored by burying them in the substrate. This technique has been used effectively both in coastal areas and along reservoir shorelines to protect them from wave action.

Along the upland fringe of trees on the east and west side appeared a 2- to 4-ft escarpment. Some trees were being undercut from wave wash in these areas. If cultural features are found in the areas above the summer pool and justify protection, then this escarpment should be treated for erosion control to prevent it from receding. This could be done by use of a combination of treatments:

- a. A rock toe that would extend from about 2 ft below summer pool to the summer pool elevation.
- b. A brush mattress and wattling combination (previously described in Barren River section) made from willow that would be placed above the rock.

Engineering approaches (Sugar Run, Nelse Run, and Red Bridge)

Surface and near-surface soils for all these sites can be characterized by three soils: Atkins silt loam, Buchanan silt loam on slopes 0 to 25 percent, and the Hartleton and Buchanan soil on slopes 25 to 60 percent. The Atkins soil has a slight erosion hazard, but the Buchanan and Hartleton are described as having a severe erosion hazard, probably due to their silty nature and steep slopes.

The Atkins silt loam is nearly level, very deep, poorly drained soil on floodplains. Typically, the surface layer is dark, grayish brown silt loam about 7 in. thick. The subsoil extends to a depth of 35 in. In the upper part, to a depth of 14 in., it is mottled, dark gray silt loam. In the lower part, to a depth of 35 in., it is mottled dark grey loam. The substratum is gray gravelly sandy loam to a depth of 65 in. or more.

The Buchanan silt loam, 0 to 8 percent, is very stony. This is a nearly level and gently sloping, deep and very deep, moderately well-drained and somewhat poorly drained soil on foot slopes and in drainage ways. Typically, the surface layer is dark brown silt loam and about 8 in. thick. The subsoil extends to a depth of 43 in. It is mottled, yellowish brown silt loam to a depth of 13 in. and mottled, yellowish brown clay loam to a depth of 26 in. Below that, to a depth of 43 in., it is a firm and brittle layer called a fragipan. The fragipan is mottled, brown gravelly clay loam to a depth of 37 in. and mottled dark brown gravelly clay loam to a depth of 43 in. The substratum is mottled, dark brown gravelly silt loam to a depth of 83 in. or more. Permeability of this Buchanan soil is moderate above the fragipan and slow in the fragipan and substratum. Rooting depth is restricted by the fragipan at a depth of about 20 to 24 in. The seasonal high water table is a depth of 18 to 30 in. in winter and spring. The soil is moderately to extremely acid. Erosion is a moderate hazard.

The Buchanan silt loam, 8 to 25 percent slopes, is also very stony. This is a strongly sloping and moderately steep, deep and very deep, moderately

well-drained to somewhat poorly drained soil of foot slopes and in drainage ways. The steepness of the slopes primarily distinguish it from the Buchanan silt loam described above. The soil is well suited to trees such as northern red oak. The soil is moderately to extremely acid. Erosion is a moderate hazard.

Hartleton and Buchanan soils, 25 to 60 percent slopes, are steep and very steep soils on hillsides with slopes 200 to 800 ft in length. The Hartleton soils are a similar interpretation to the Buchanan soils. They range from extremely acid to strongly acid. Erosion is a severe hazard.

Philo silt loam is a nearly level, very deep, moderately well-drained soil on floodplains. Slopes range from 0 to 3 percent. Typically, the surface layer is dark grayish brown silt loam about 7 in. thick. The subsoil is yellowish brown silt loam to a depth of 15 in. and mottled brown fine sandy loam to a depth of 34 in. The substratum is mottled, gray sandy loam to a depth of 46 in. and gray very gravelly loamy sand to a depth of 66 in. or more. The soil ranges from slightly acid to very strongly acid throughout. Erosion is a slight hazard. The soil is suited to trees. The potential habitat for wetland plants is poor. Site protection strategies shown in Table 3 are recommended.

Table 3 Potential Erosion Control Methods for Allegheny Archaeological Sites in the Drawdown Zone				
Site	Predominant Erosion Mechanism	Additional Design Concerns	Site Protection Method	Comments/ Recommendations
Allegheny Reservoir, Pennsylvania 36WA2 (Sugar)	Wave, overtopping, drawndown	Silt and loam on 0 to 60 percent slope, corrosion	Potential subimpoundment	Some deposition, HeF and BxD soil
Allegheny Reservoir, Pennsylvania 35MC29 (Nelse)	Wave, overtopping, drawndown	Corrosion	Potential subimpoundment; Geoweb w/rock	Potential severe erosion on steep slopes, HeF and BxD
Allegheny Reservoir, Pennsylvania Riverview	Wave, overtopping, and overland flow	Corrosion	Riprap	Contractor proposal should be reviewed, ChB soil
Allegheny Reservoir, Pennsylvania Red Bridge	Wave, overtopping, drawndown	Corrosion and inundation at summer pool	Subimpoundment and Geoweb	BxB soil
Allegheny Reservoir, Pennsylvania Steamburg	Return flow, ice, debris removal by current	Corrosion	Geoweb, stacked, soil fill, vegetation, and granular backfill	Flexible fix to sustain ice gouging and flows

Steamburg Sites (C-30CA15,16,17,35, and 36)

These sites represent a series of Late Woodland/Proto-Erie villages that were partially excavated by Dr. Stan Lantz during the period 1969-74. Numerous longhouse postholes, storage pits, and burials have been recorded at these locations. The sites are located entirely on the Seneca Nation reservation. They are located at elevations 1,325 to 1,328 ft and are totally exposed by the annual winter drawdown. They are being severely eroded by ice gouging during the annual spring ice breakup. Because of their location on the Seneca reservation, they are not under the control of the Forest Service. While the normal operation of the Allegheny Reservoir is negatively impacting these sites, the Corps' Pittsburgh District claims it has no responsibility toward these sites. A discussion of the District's legal responsibility for these sites under ER 1130-2-438 and 36 CFR 800 appears in the summary section of the case study.

Geomorphic assessment

The "Steamburg" sites occur in the upper end of the reservoir on the active floodplain of the Allegheny River (Figures 49-52). The stratigraphy of the

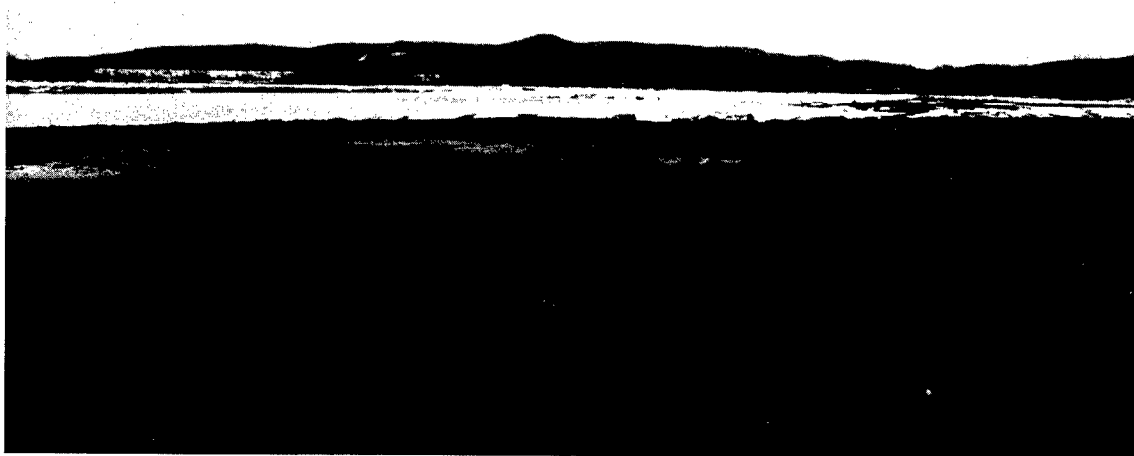


Figure 49. Steamburg site area: Area in foreground is inundated by summer pool



Figure 50. Steamburg site area: Ice gouging and plucking of riverbank during winter drawdown

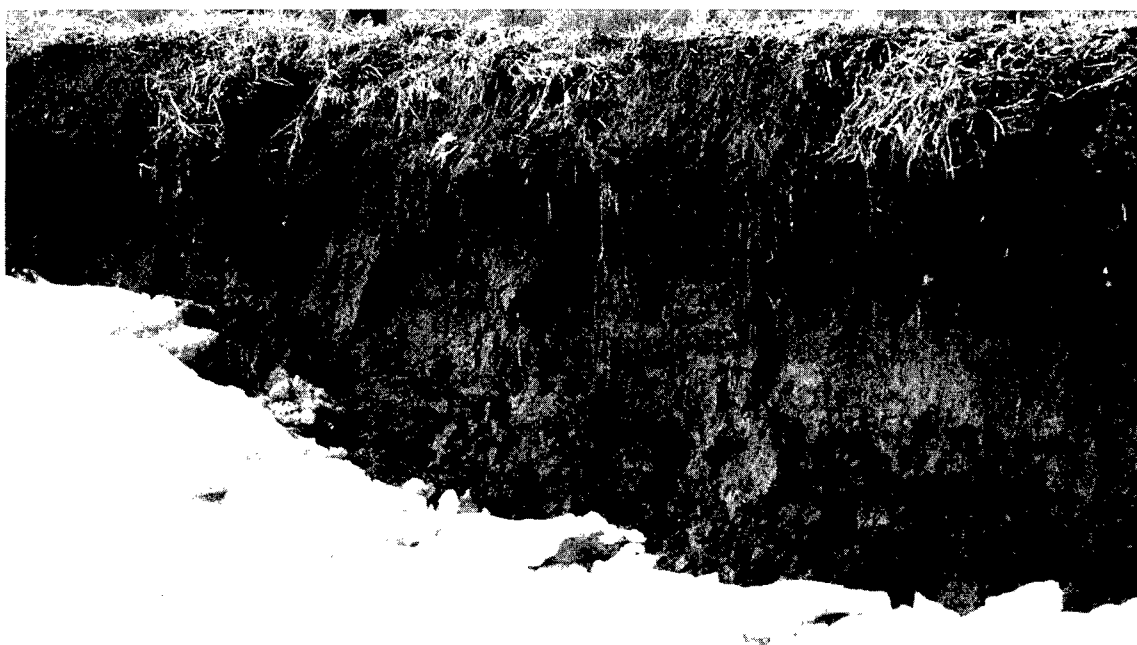


Figure 51. Steamburg site area: Exposed archaeological midden in cut bank is being rapidly eroded



Figure 52. Steamburg site area: View of canary grass on surface of archaeological site

sites consists of massive fine-grained vertical accretion deposits of sandy silt that contain several stratified middens. These soils offer very little resistance to erosion as indicated by the wide variety of active geomorphic processes at the site. The bank line is being rapidly eroded by streamflow, overland flow, soil falls and slides, waves, piping, and ice. During the visit to the site, ice gouging and plucking of the bank line was immediately obvious (Figures 49-52). During summer pool, the site appears to be inundated by 3 to 5 ft of water.

Mitigation of the adverse effects of erosion along the shoreline of these sites might involve both a winter and a summer solution. The winter solution would protect the eroding streambank from ice, waves, and streamflow. The summer solution would protect the site surface from waves and currents.

Bioengineering approaches

Since the sites by the river channel are covered by water most of the year, a vegetative treatment on the banks of the river itself has little chance of growth success. Therefore, the riverbank itself should be protected with traditional methods, such as riprapped revetment. However, there were places above the top of the bank that exhibited vegetation. This consisted primarily of reed canary grass on some of the flats, and there were islands of silverleaf

maple and black willow right at or just above summer pool. Where vegetation exists, this could be augmented with other flood-tolerant vegetation that would grow over and protect existing sites.

Where reed canary grass exists, other more flood-tolerant plants could possibly be planted lower into the flood pool. Such plants would include various grasses, sedges, and rushes. Grasses may include switch grass (*Panicum virgatum*), prairie cordgrass (*Spartina pectinata*), and maidencane (*Panicum hemitomon*). Sedges may include such plant species as a spike sedge (*Eleocharis quadrangulatus*), bullrushes (*Scirpus* spp.) and various *Carex* species. Rushes may include such plants as common rush (*Juncus effusus*).

Where the edges of the islands exist and along the edge of the old highway, some erosion is occurring due to wave action and current scour. If cultural resources exist in any of these areas, bioengineering treatments incorporating willow could be used. Treatments may consist of the willow post method referenced above for the cemetery site or brush mattresses mentioned in the Barren River report.

Engineering approaches

The Soil Conservation Service Soil Survey report for this part of New York (Seneca Nation Reservation Land) was not available. The adjacent county to the west, Cattaraugus, indicated similar cautions for erosion potential encountered in McKean and Warren counties, Pennsylvania. Table 3 shows the recommended engineering alternatives for all the Allegheny Reservoir sites.

Management Summary

36WA2 (Sugar Run Village and Mound)

No site protection actions should be taken at this time. Should there be a major drawdown in the future and the site is exposed, an assessment of the site's condition should be done expeditiously. This site should be included in the monitoring plan section of the project HPMP when it is completed.

36MC29 (Nelse Run)

The major recorded feature (Adena burial mound) has been destroyed by the effects of pool fluctuation. An intensive survey of the adjacent terrace should be conducted in the near future. The site protection efforts described by Hollis Allen should be directed towards any intact cultural deposits at or

just above the summer pool elevation. The eligibility of these deposits should be determined prior to the expenditure of funds for their protection.

Riverview/Corydon Cemetery

The National Register eligibility of this site must be formally determined through coordination with the Pennsylvania SHPO. The association with Cornplanter may give it associative significance under National Register Criteria B (historic person). The cemetery must be determined eligible for the National Register to warrant the long-term management or mitigation of adverse effect required by law. If there should be disagreement between the lead Federal agency (Forest Service or Corps of Engineers) and the SHPO over the site's eligibility, a request for a formal determination of eligibility should be sent to the Keeper of the National Register to resolve this disagreement.

Regarding the legal responsibility for mitigation of the adverse effect caused by the operation of the reservoir, Corps Regulation ER 1130-2-438 (paragraph 7f) provides this guidance:

“On lands held in less than fee by the Federal Government under Corps of Engineers jurisdiction, the District Commander has the same responsibility for historic properties whenever activities generated by the Corps will have an adverse impact on those properties. If Corps action will impact the property, the Corps is empowered to acquire necessary real estate interests to enable it to carry out the intent of Congress in mitigating adverse impacts to historic properties resulting from Corps activities.”

The authors' interpretation of this regulation is that if the Corps' utilization of its flowage easement is adversely affecting a National Register eligible cemetery, the Corps is responsible for acquiring a real estate interest and paying the costs of mitigation. Since the land being affected is already owned by the Forest Service, acquisition of the real estate interest necessary to carry out a mitigation plan should not be a problem. The cost of protecting the site is a serious concern. The site protection plans discussed by Hollis Allen may represent a possible short-term solution. The long-term solution could be found in one of the alternatives presented in Appendix B with the caveat that such plans may be even more expensive to construct in today's economy.

It should also be noted that the simple periodic relocation of graves away from the eroding edge of the cemetery, as suggested by members of the Pittsburgh District staff during the WES team's visit, could be regarded by the SHPO as an adverse effect requiring mitigation through the preparation of a case study dealing with the historic significance and use of the cemetery. However, this might be a far less expensive option than a long-term engineering solution to the continuing erosion problem.

The Red Bridge Sites (03-338A,B and 03-339)

The proposal now being studied by the Pittsburgh District to enclose the area in a "sub-impoundment" for various natural resource management objectives has promise of providing protection of the area from erosion as well. As noted by Dr. Lawson Smith, the "sub-impoundment" would result in some sedimentation on the land surface, serving to protect the sites in the area. Vegetative site protection is not recommended for these sites. The use of geotextiles or some form of armoring of these sites as suggested by Hollis Allen should be further explored after a formal determination of their eligibility has been made by the Corps and SHPO.

The Steamburg Sites (C-30CA15,16,17,35, and 36)

These sites are all located on the Seneca Nation reservation and have never been formally evaluated for their National Register status. If they are ever determined eligible by the Pennsylvania SHPO, the same mitigation responsibility described in ER 1130-2-438 paragraph 7f would descend on the Corps of Engineers' Pittsburgh District since it is the Corps' flowage easement that is adversely affecting these sites. Acquiring "sufficient real estate interest" in order to conduct any form of mitigation will be a major problem, given the friction that exists between the Seneca and the Corps. Short-term, these authors recommend that the Forest Service archaeologists provide technical support to the Seneca's own archaeologist, Dr. Robert Dean, in evaluating the integrity of these sites and the preparation of a monitoring plan. Regarding their long-term protection, erosion along the shoreline of these sites should involve both a winter and a summer solution. The winter solution would protect the eroding streambank from ice, waves, and streamflow. The summer solution would protect the site's surface from waves and currents.

11 Conclusions

This second technical report for the EIRP work unit on drawdown impacts has concentrated on identifying techniques for the effective management of historic properties in reservoir drawdown zones. Management techniques have been identified through ongoing WES projects for Corps Districts nationwide and from one of the author's 1995 field visits to nine COE reservoirs. Three case studies from the Ohio River Division have been presented to illustrate the range and complexity of management problems now being encountered in the field. The case studies have also provided an opportunity to show how the management techniques discussed in the first portion of the report might actually be implemented.

Regulation 36 CFR 800 has provided the general organizational framework for the management approach taken here. The identification of all historic properties (through a process of site evaluation) that might be present in a reservoir's drawdown zone is a critical first step. This process of evaluation is analogous to applying the criteria of eligibility to affected sites during the planning stages of a new construction project. In this report and in the first technical report for the work unit (Dunn 1996:6), it has been argued that operational drawdowns should be regarded as "Federal undertakings" subject to the Section 106 (National Historic Preservation Act) process and its implementing regulation 36 CFR 800.

It has been proposed that traditional site testing as an evaluation technique should be supplemented, or even supplanted in some cases, by a variety of available site evaluation techniques. In the complex process of determining site significance, the use of remotely sensed images, aerial photography, geophysical techniques, and GIS is not only recommended but rapidly becoming professionally mandated.

Assessing the impacts to identified historic properties corresponds very well to the application of the criteria of effect in the Section 106 process. It has been shown that a detailed geomorphic assessment of the altered fluvial system that is the man-made reservoir is essential to planning effective countermeasures. The assessment of human impacts to eroding historic properties goes hand in hand with that geomorphic assessment. When eroding sites are effectively protected, vandalism also declines.

The mitigation of the adverse effects of cyclic inundation and exposure is the most critical and expensive step in the management process. The Corps is required by law and regulation to prevent, ameliorate, or mitigate the adverse effects of reservoir operations on identified historic properties. Site protection technology is rapidly evolving, and the conclusions of the National Reservoir Inundation Study 20 years ago that data recovery should be the preferred treatment of sites in the drawdown zone are no longer valid in all cases. At the same time, site protection projects will very often include a data recovery component. In the approach taken here, they should be regarded as equal partners. For some sites, data recovery will take a larger share of the mitigation project budget than site protection.

Regarding the long-term management of historic properties, the creation of a Historic Properties Management Plan has been shown to be not only a Corps regulatory requirement but a crucial tool for good management. It has been argued in this report that the creation of a detailed Drawdown Zone Protection Plan is an appropriate and necessary component of a good HPMP. The preparation of a Cultural Resources Monitoring Plan, incorporating an analytical geomorphic model of erosion rates and processes for a given reservoir, is another recommended technique for effective management. This kind of long-term monitoring plan is best integrated into a GIS.

Specific recommendations for counteracting the continuing problem of vandalism of historic properties include the following: additional manpower for patrols either through increased FTE or by contracts; improved training for cultural resource coordinators, training of all rangers in ARPA law enforcement, the use of warning signs not immediately adjacent to archaeological sites but in heavily used areas; the use of electronic surveillance technology at threatened sites, and a greater emphasis on the interpretation of historic properties to the public.

The case studies at Barren River Lake, Bluestone Lake, and Allegheny Reservoir have demonstrated that historic properties in reservoir drawdown zones will continue to challenge both the Corps as a corporate entity and individual cultural resource managers. The protection of these significant sites and their information potential, both for the scientific community and the general public through their interpretation, is a worthy but extremely difficult task.

With the exception of the Jewell Mound site at Barren River Lake, which now would benefit most from an intensive archaeological data recovery project, all the sites discussed in these case studies are potential candidates for site protection. Many of these sites can be protected at relatively low cost through bioengineering approaches. A few sites (e.g., the Riverview/Corydon Cemetery at Allegheny Reservoir) will require a substantial financial commitment to ensure their long-term survival. In most cases, some data recovery will be necessary even when the primary goal is protection of the site. In all cases, future monitoring and the implementation of an HPMP that specifically addresses drawdown impacts will be necessary to meet the challenge of

stewardship that has been given to the Corps by the National Historic Preservation Act. But, as noted in Dunn (1996:29), "the author is confident that the Corps' response to legally responsible and scientifically sound management recommendations for historic properties in reservoir drawdown zones will be 'Essayons,' Let us try!"

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Appendix A

Geomorphology Data Sheets and Site Sketches

RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Barren River Reservoir SITE 15-BN-384

LOCATION _____ DATE 2/21/96

OBSERVERS Dunn, Allen, Taylor, Bader, Crabbe, Smith

POOL ELEVATIONS: Summer 552 Winter 525 Maximum 583 Current 526

WEATHER CONDITIONS PC, cool, little wind, no precip.

LANDSCAPE/LANDFORM Upper terrace on point

SHOREFACE: Width ~70' Slope ~60° Materials see sketch

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland Flow-Sheet, Rill, Channel; Reservoir Current.

WAVES: Breaking, Swash, Circulation; Boat Generated Fetch ~1 mile

ICE: Plucking, Gouging, Battering

RAIN SPLASH, PIPING, WIND, FREEZE/THAW, CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

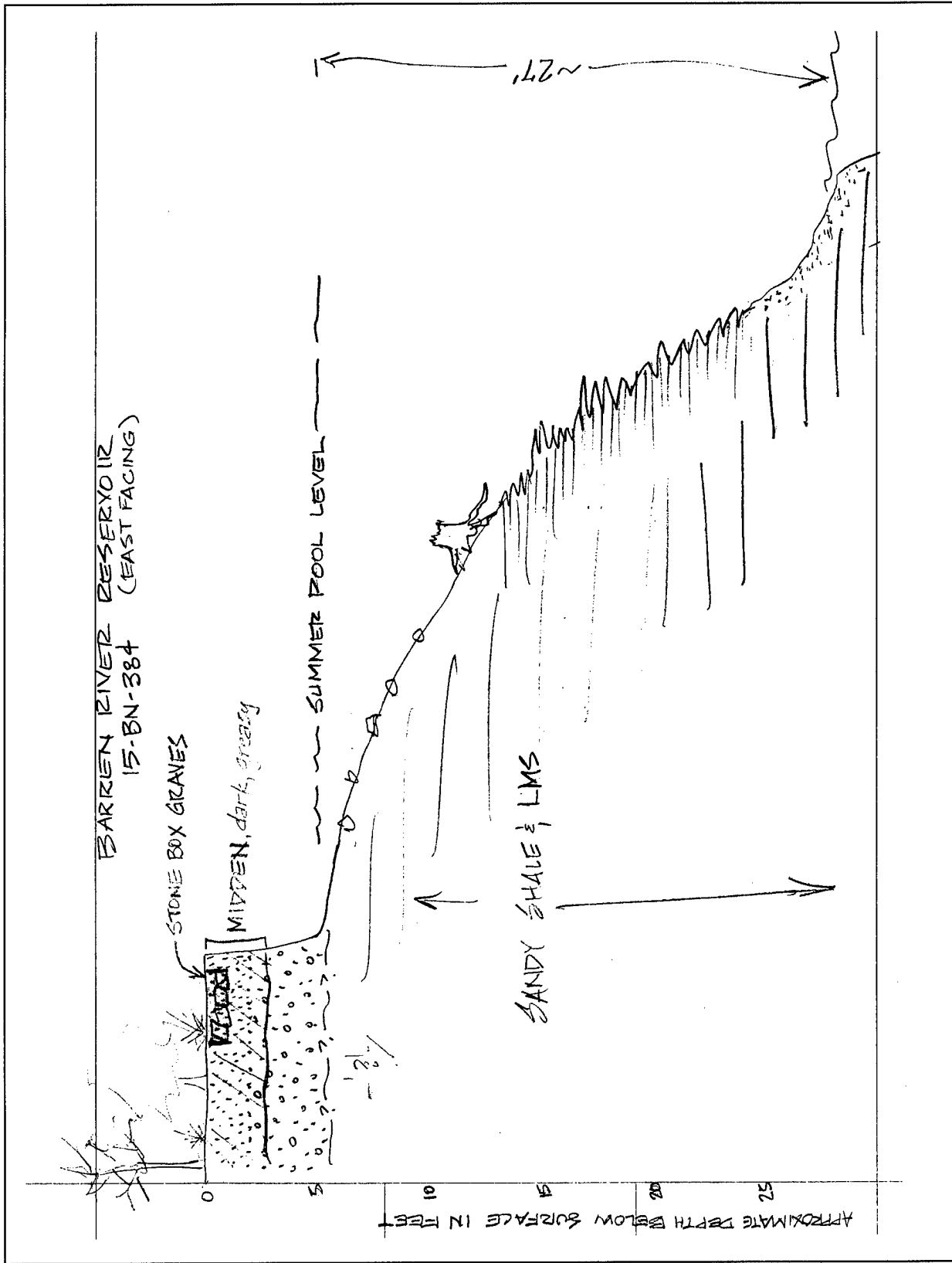
ICE

OTHER SITE DESTRUCTIONAL PROCESSES Frequent collecting

VEGETATION None on shoreface

COMMENTS Underlying (in-situ) strata of thinly bedded shale and sandstone rapidly (readily) disintegrates.

See attached sketch.



RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT BARRENA. Reservoir SITE 15-AL-329

LOCATION _____ DATE 2/20/96

OBSERVERS Dunn, Allen, Taylor, Bader, Crabbe, Smith

POOL ELEVATIONS: Summer 552 Winter 525 Maximum 583 Current 526

WEATHER CONDITIONS PC, warm, breezy, no precip.

LANDSCAPE/LANDFORM Thin alluvial terrace on valley side

SHOREFACE: Width ~240' Slope ~2° Materials shale and sandstone fragments, "bathtub" lines

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland ~~Flow-Sheet~~, Rill, Channel; Reservoir Current.

WAVES: Breaking, Swash, Circulation, Boat Generated. Fetch ~1.5 mile

ICE: Plucking, Gouging, Battering

RAIN SPLASH, PIPING, WIND, FREEZE/THAW, CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

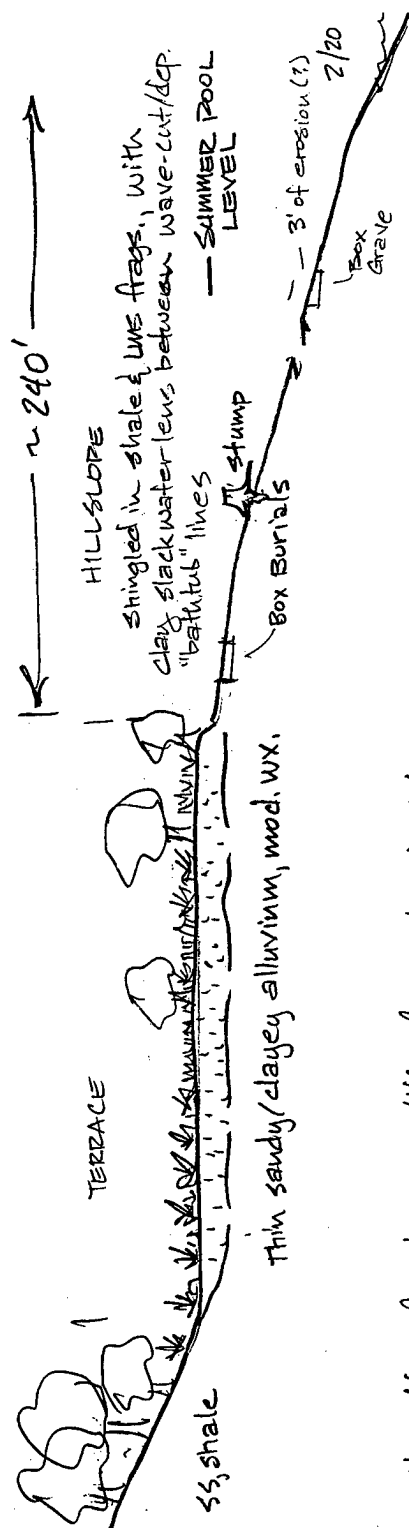
ICE

OTHER SITE DESTRUCTIONAL PROCESSES Collecting

VEGETATION None on shoreface. Top of shoreface is willow

COMMENTS Waves are principle processes, responsible for ~3 feet of vertical erosion. Stone box graves being eroded, collected.

BARREN RIVER RESERVOIR, SITE 15-AL-329
2/20/96



No pottery found, many lithic frags., box burials

Processes: Waves, some or flow, freeze/thaw, seepage, dispersion(?); wind(?)

RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Barren River Reservoir SITE 15-AL-8

LOCATION _____ DATE 2/21/96

OBSERVERS Dunn, Allen, Taylor, Bader, Crabbe, Smith

POOL ELEVATIONS: Summer 552 Winter 525 Maximum 583 Current 526

WEATHER CONDITIONS Clear, warm, breezy, no precip.

LANDSCAPE/LANDFORM Terraces, floodplain

SHOREFACE: Width 1200' Slope 0 Materials fine grained alluvium

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland Flow-Sheet, Rill, Channel; Reservoir Current

WAVES: Breaking, Swash, Circulation; Boat Generated. Fetch _____

ICE: Plucking, Gouging, Battering

RAIN SPLASH, PIPING, WIND, FREEZE/THAW, CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

ICE

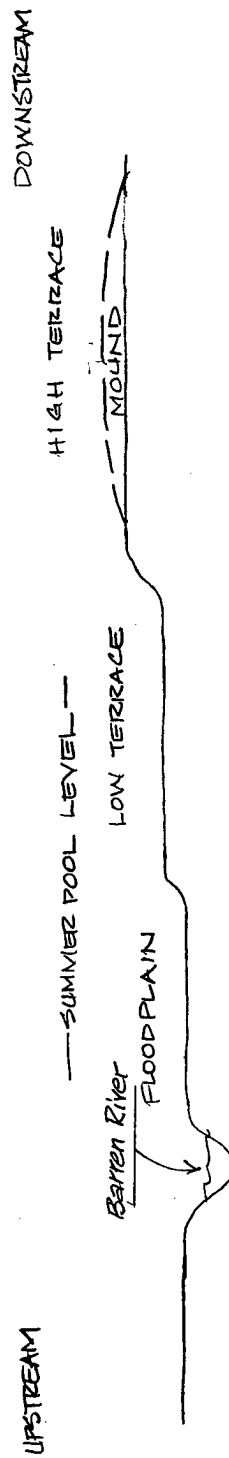
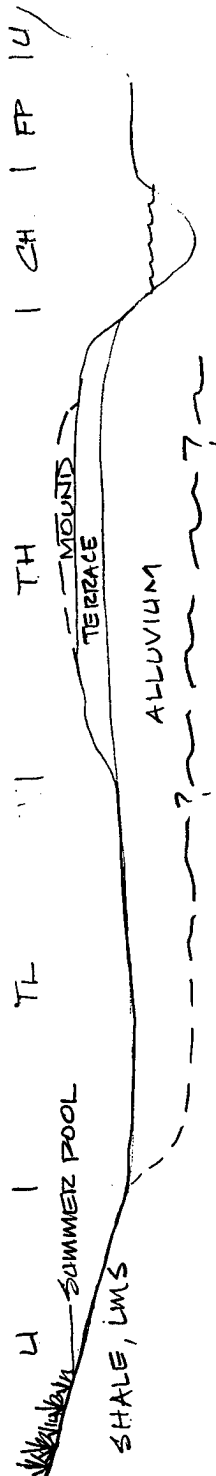
OTHER SITE DESTRUCTIONAL PROCESSES _____

VEGETATION None on site

COMMENTS Some sedimentation during falling stages,
net erosion of 2-3 feet.

see attached sketch

BARREN RIVER RESERVOIR: SITE 15-AL-8



RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Bluestone Reservoir, WV. SITE 46-SU-3

LOCATION _____ DATE 3/5/96

OBSERVERS R. Dunn, H. Allen, B. Taylor, D. Eskridge, B. Maslowski, L. Smith

POOL ELEVATIONS: Summer 1410' Winter 1406' Maximum 1495' Current 1406'

WEATHER CONDITIONS PC, 50's F, no precip, windy

LANDSCAPE/LANDFORM Flooded low terrace in alluvial valley of the New River.

SHOREFACE: Width ~300' Slope ~1% Materials Silty sand, occasional sand patches, Heavy litter of ceramics, bone, lithic debris

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland Flow Sheet, Rill, Channel; Reservoir Current

WAVES: Breaking, Swash, Circulation; Boat Generated Fetch _____

ICE: Plucking, Gouging, Battering

RAIN SPLASH, PIPING, WIND, FREEZE/THAW, CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

ICE

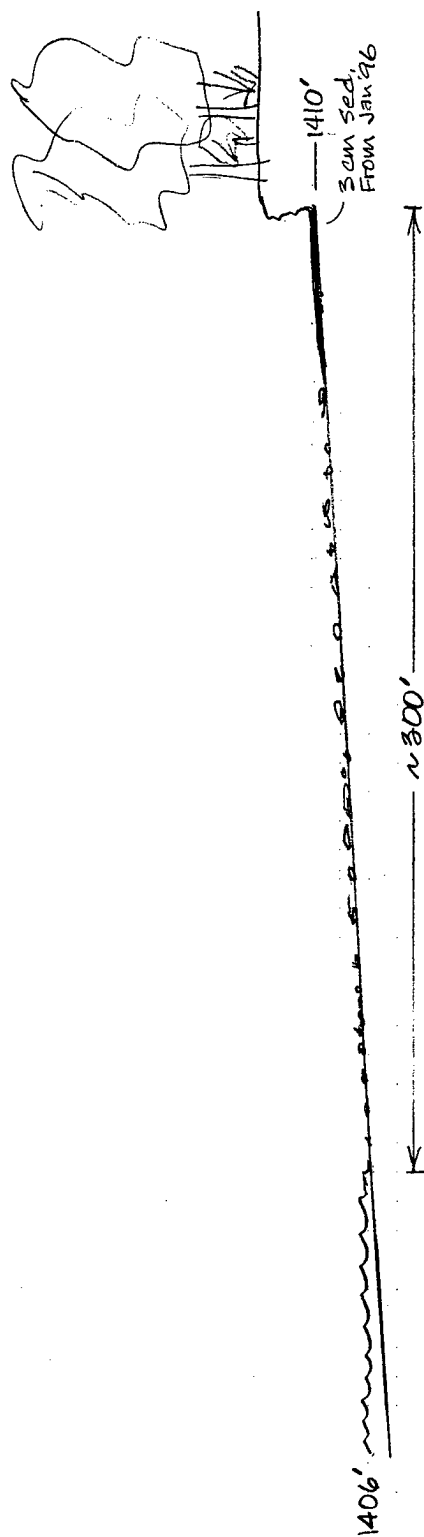
OTHER SITE DESTRUCTIONAL PROCESSES vandalism (surface collection)
bioturbation

VEGETATION Trees on upper surface of "island", bare on eroded point

COMMENTS Probably 2-4 feet of fine grained alluvium eroded from site, leaving heavier artifacts clustered on the site. Some deposition occurring falling stages of floods. Net erosion.

see attached sketch.

BLUESTONE RESERVOIR WV: SITE 46-SU-3
3/5/96



GEOMORPHIC SETTING: RIDGE ON LOW TERRACE, NOW AN ISLAND IN RESERVOIR
ACTIVE PROCESSES: WAVE EROSION, STREAM FLOW EROSION DURING FLOODS; ARTIFACTS
ARE WINDOWED OUT, SOIL-MATRIX REMOVED, SOME SED. DURING FALLING FLOOD
VERTICAL ACCRETION DEPOSITS ON UNERODED ISLAND, 7-8cm DEPOSITED
IN JAN 96 FLOOD.

RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Bluestone Reservoir, WV. SITE 46-SU-22

LOCATION Crump Bottom DATE 3/6/96

OBSERVERS R. Dunn, H. Allen, B. Taylor, B. Maslowski, L. Smith

POOL ELEVATIONS: Summer 1410' Winter 1406' Maximum 1495' Current 1406'

WEATHER CONDITIONS PC, cool (50's F)

LANDSCAPE/LANDFORM Upper terrace in New River alluvial valley

SHOREFACE: Width ~3500' Slope < 1% Materials Silty sand

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland Flow-Sheet, Rill Channel; Reservoir Current.

WAVES: Breaking, Swash, Circulation; Boat Generated. Fetch _____

ICE: Plucking, Gouging, Battering

RAIN SPLASH, PIPING, WIND, FREEZE/THAW CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

ICE

OTHER SITE DESTRUCTIONAL PROCESSES Disturbance by agricultural processes (plowing), collecting.

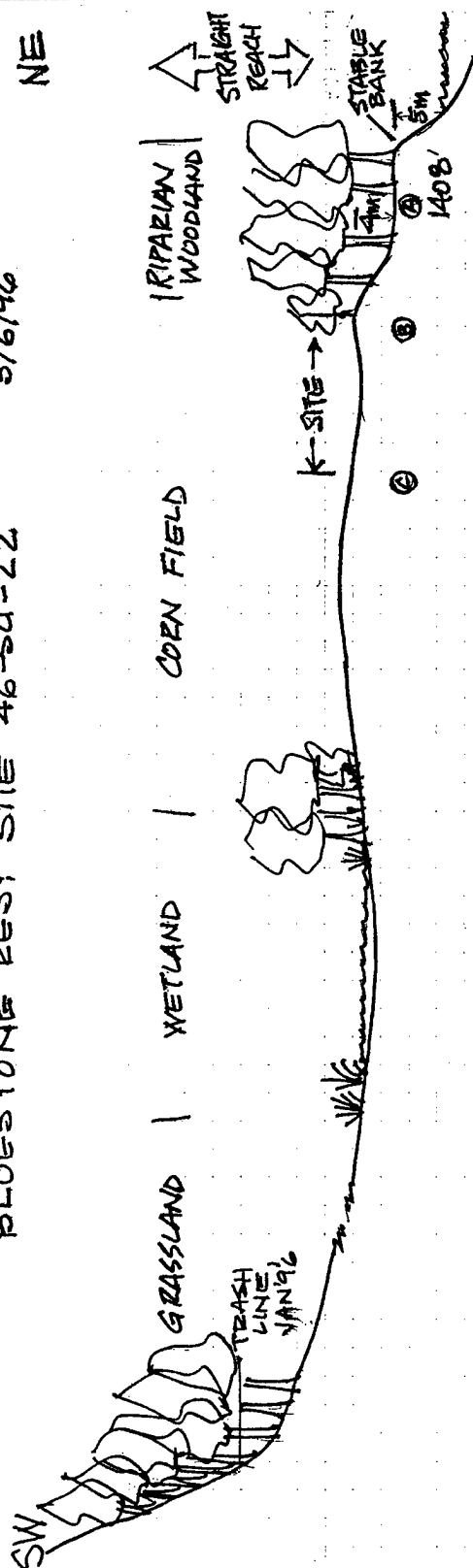
VEGETATION Corn (seasonal)

COMMENTS Deposition of several cm of sandy silt occurred during flood of Jan-Feb 96. Site is not negatively impacted by reservoir fluctuation, except possibly during extreme floods.

See attached sketch.

3/6/96

三



TE: TERRACE EQUIPMENT
TL: LOW TERRACE
EP: FLOOD RAIN

Reaches of river is straight, rock bottom, appears stable, flow 2-3 f.p.s.

Site experiencing sedimentation. During Jan 96 flood, sed at A \approx 8 cm; B \approx 3 cm; C \approx 1 cm.

Processes: bioturbation, plowing.

RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Bluestone Reservoir, WV. SITE 46-SU-20

LOCATION Crump Bottom DATE 3/6/96

OBSERVERS R. Dunn, H. Allen, B. Taylor, B. Maslowski, L. Smith

POOL ELEVATIONS: Summer 1410' Winter 1406' Maximum 1495' Current 1406'

WEATHER CONDITIONS PC, Cool, breezy

LANDSCAPE/LANDFORM Upper terrace in New River alluvial valley

SHOREFACE: Width ~2000' Slope <1% Materials Silty sand

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland Flow-Sheet, Rill Channel; Reservoir Current.

WAVES: Breaking, Swash, Circulation; Boat Generated. Fetch _____

ICE: Plucking, Gouging, Battering

RAIN SPLASH PIPING, WIND FREEZE/THAW CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

ICE

OTHER SITE DESTRUCTIONAL PROCESSES Disturbance by agricultural processes (plowing, cultivating), collecting.

VEGETATION Corn (seasonal)

COMMENTS Setting very similar to site 46-SU-22.
Some deposition during Jan-Feb 96 flood, but less than 46-SU-22.
Valley is more narrow than 55-22.

RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Allegheny Reservoir SITE Riverview/Corydon

LOCATION _____ DATE 3/14/96

OBSERVERS R. Dunn, B. Taylor, S. Lantz, L. Smith

POOL ELEVATIONS: Summer 1328' Winter 1300' Maximum _____ Current 1300'

WEATHER CONDITIONS PC - Clear, Cool (50's F), no precip.

LANDSCAPE/LANDFORM Outwash terrace on valley wall

SHOREFACE: Width 270' Slope Seq. Materials Rounded conglomerate over bedded sand over Paleozoic sand stone

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland Flow-Sheet, Rill, Channel; Reservoir Current.

WAVES: Breaking, Swash, Circulation; Boat Generated. Fetch See below

ICE: Plucking, Gouging, Battering

RAIN SPLASH, PIPING, WIND, FREEZE/THAW, CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

ICE

OTHER SITE DESTRUCTIONAL PROCESSES Site frequently collected

VEGETATION Scattered shrubs above summer pool. Sandy soil has low moisture, inhibiting veg. growth

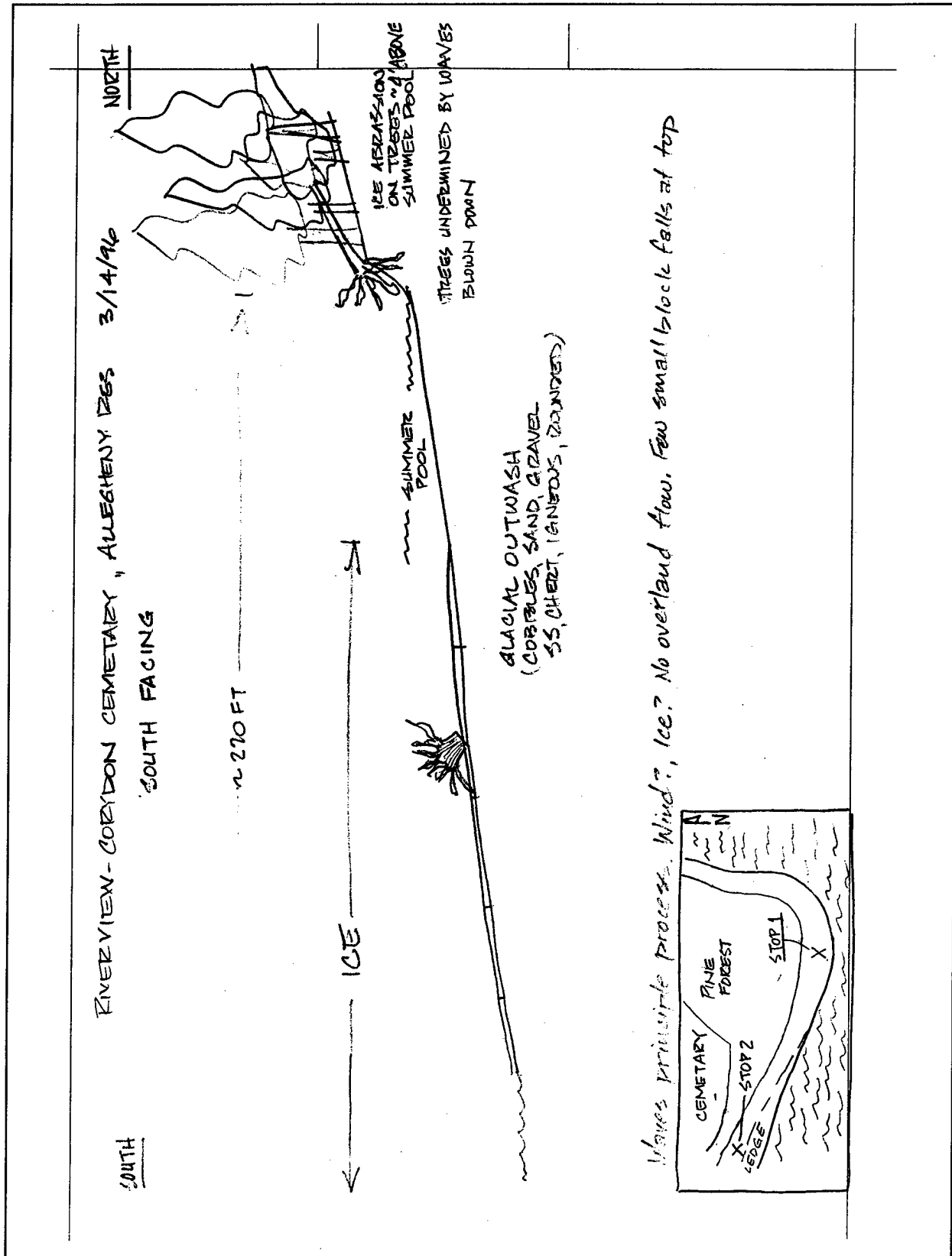
COMMENTS Bluff face of terrace appears to be rapidly receding. Conglomerate rapidly cemented by carbonates

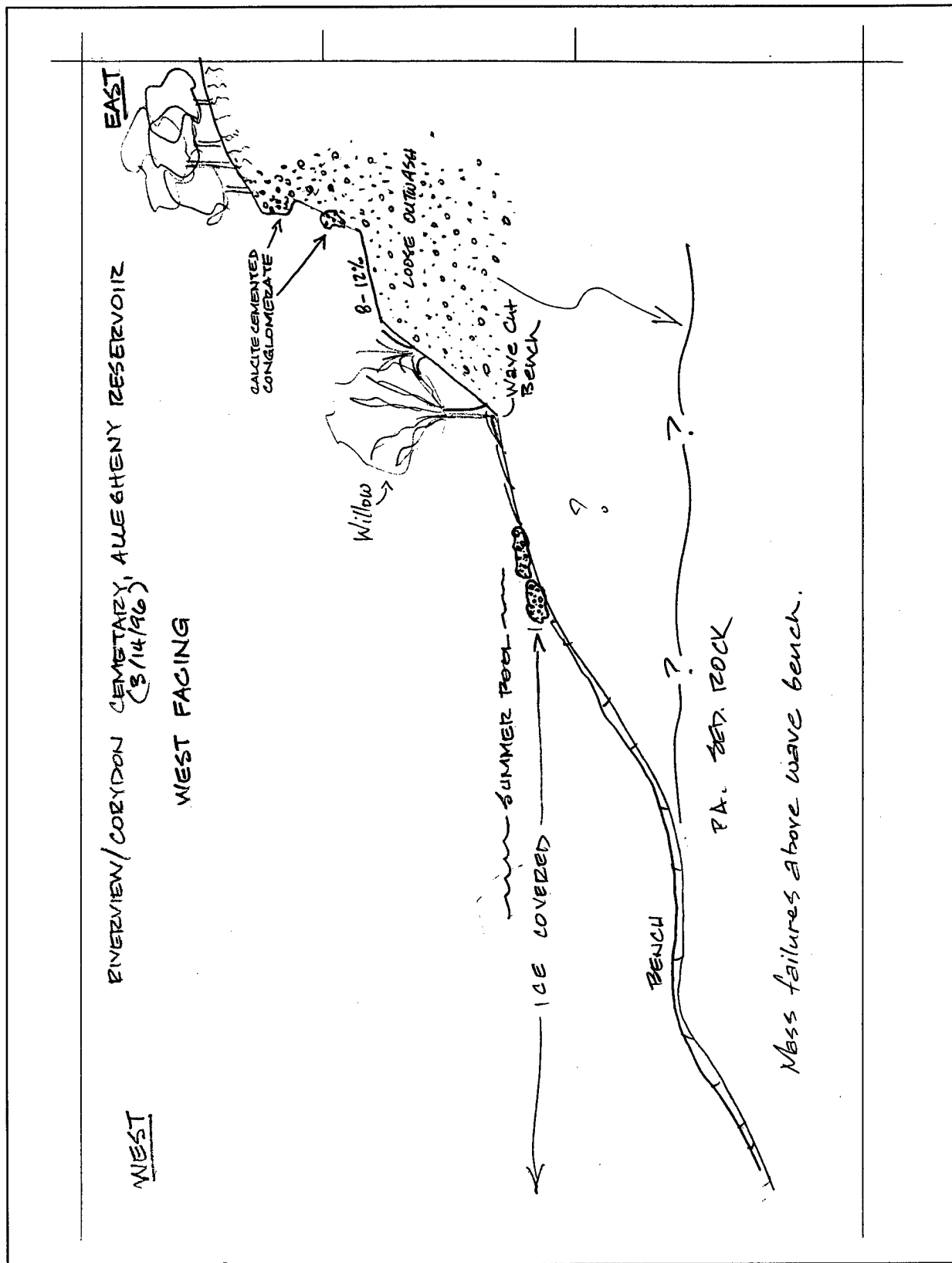
* Fetch: From the south, the fetch is > 8 miles, approximately 3/4 mile from west end NW.

See attached sketches (2)

A14

Appendix A Geomorphology Data Sheets and Site Sketches





RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Allegheny Reservoir SITE Nelse Run
LOCATION _____ DATE 3/12/96
OBSERVERS Dunn, Allen, Taylor, Lantz, Kavinsky, CoE, USFS, L. Smith
POOL ELEVATIONS: Summer 1328 Winter 1300 Maximum _____ Current 1300
WEATHER CONDITIONS Clear, very cool (40's), no precip.
LANDSCAPE/LANDFORM Tributary floodplain (aggrading to Allegheny Reservoir)
SHOREFACE: Width ~400' Slope < 1° Materials Fine grained alluvium, (silty sand)

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.
FLUID SHEAR: Overland Flow-Sheet, Rill, Channel, Reservoir Current.
WAVES: Breaking, Swash, Circulation; Boat Generated. Fetch < 1 mi.
ICE: Plucking, Gouging, Battering
RAIN SPLASH, PIPING, WIND, FREEZE/THAW, CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION
FLUVIAL
LACUSTRINE
ICE

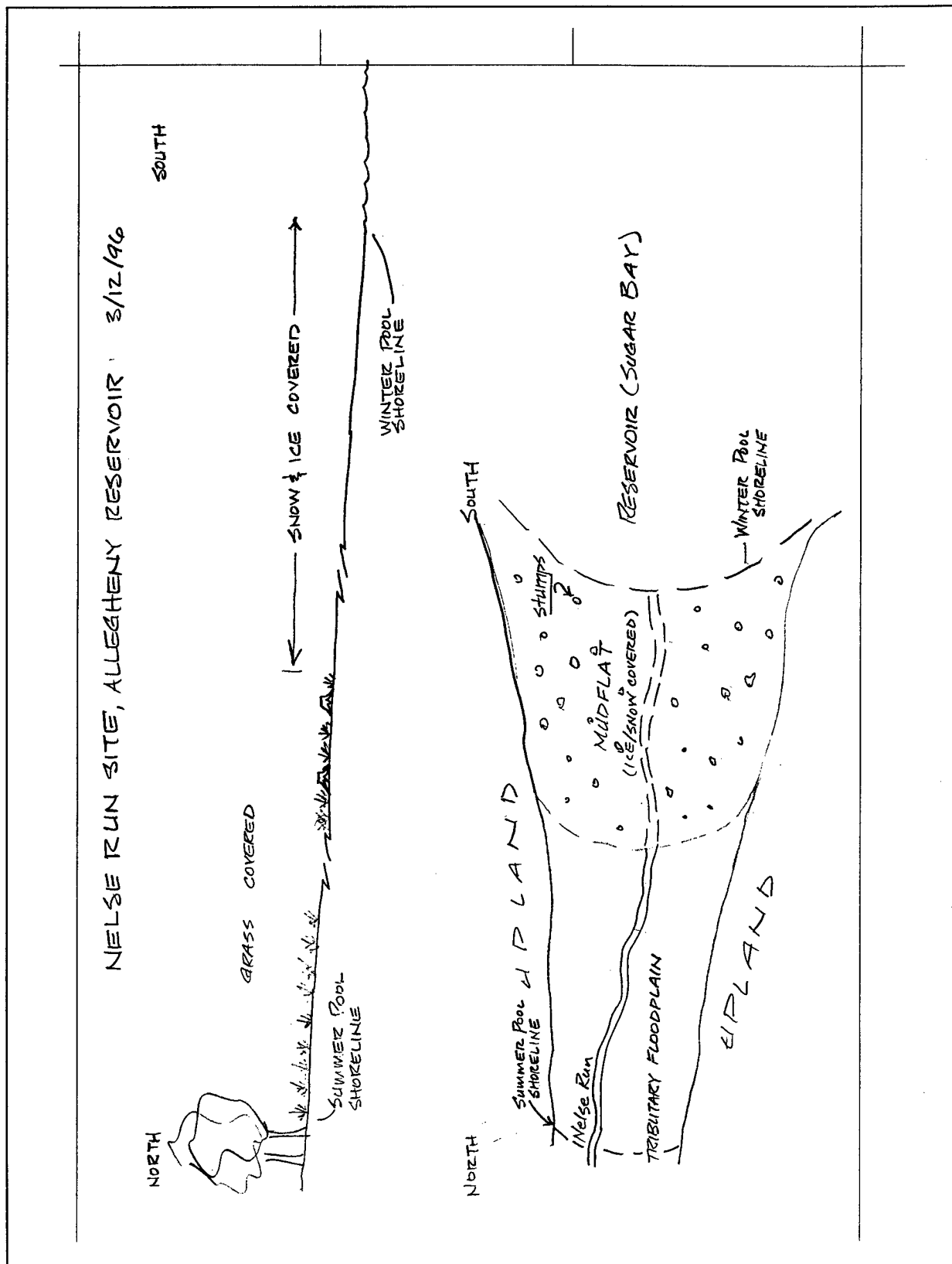
OTHER SITE DESTRUCTIONAL PROCESSES Collecting

VEGETATION Eel grass on upper shore face (< 2' water at summer pool)

COMMENTS Site is location of steady vertical accretion prior to reservoir. May be a stratified site

Up to 80 cm of soil erosion may have occurred on the lower shelf of the site.

See attached sketch.



RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Allegheny Reservoir SITE Red Bridge

LOCATION _____ DATE 3/13/96

OBSERVERS Dunn, Allen, Taylor, Lantz, CoE, USFS, L. Smith

POOL ELEVATIONS: Summer 1328 Winter 1300 Maximum _____ Current 1300

WEATHER CONDITIONS Clear, cool (high 40's)

LANDSCAPE/LANDFORM Floodplain of Kinzua Creek ~ 8 mi.
upstream of Allegheny River.

SHOREFACE: Width N/A Slope Flat Materials clayey silt, sandy
silt.

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland Flow-Sheet, Rill, Channel; Reservoir Current

WAVES: Breaking, Swash, Circulation; Boat Generated. Fetch variable

ICE: Plucking, Gouging, Battering

RAIN SPLASH, PIPING, WIND, FREEZE/THAW, CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

ICE

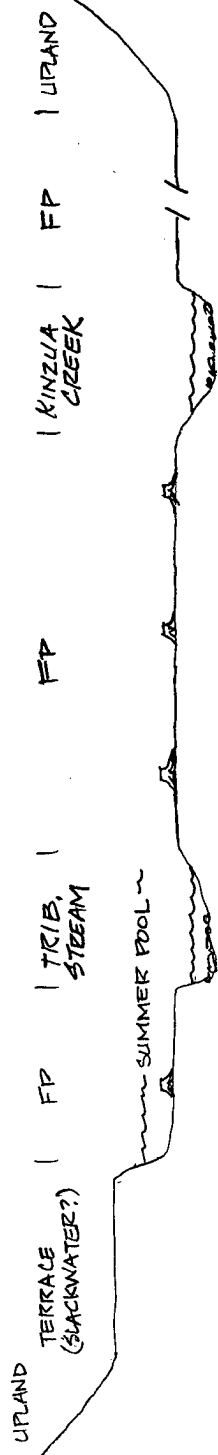
OTHER SITE DESTRUCTIONAL PROCESSES collecting(?)

VEGETATION None

COMMENTS Site has 4-8 feet of water during summer
pool. Some temporary sed. occurring

See attached sketch

RED BRIDGE SITES, ALLEGHENY RES. 3/13/96



On active floodplain of Kinzua Creek ~ 7-8 miles upstream of Allegheny River. Sites are flooded 3-5 feet during summer pool. Some erosion has occurred (waves), also some clayey silt deposition. Surface flowing / musing. Dark OM-rich zone only few inches deep, then clayey-silt (orange). Streambanks actively eroding by streamflow & block falls. Local ss cobbles in bed of stream

Cultural materials: Ceramics, lithics, FCR, organic features.

Site Destruction Processes: Vandalism (collecting), some erosion, wetting/drying, freeze/thaw, chem. wx. some streambank erosion.

RESERVOIR SHORELINE EROSION SITE VISIT
GEOMORPHOLOGY DATA SHEET

PROJECT Allegheny Reservoir SITE Steamburg

LOCATION _____ DATE 3/13/96

OBSERVERS Dunn, Allen, Taylor, Lantz, CoE, USFS, Dean, L. Smith

POOL ELEVATIONS: Summer 1328 Winter 1300 Maximum _____ Current 1300

WEATHER CONDITIONS PC, windy, cool, no precip.

LANDSCAPE/LANDFORM Floodplain, upper end of reservoir

SHOREFACE: Width 20' Slope 90° Materials clayey, sandy silt, sand, OM rich

EROSIONAL PROCESSES

MASS FAILURE: Rock Fall, Slide, Flow; Soil Fall, Slide, Flow.

FLUID SHEAR: Overland Flow-Sheet, Rill, Channel; Reservoir Current.

WAVES: Breaking, Swash, Circulation; Boat Generated. Fetch _____

ICE: Plucking, Gouging, Battering

RAIN SPLASH, PIPING, WIND, FREEZE/THAW, CHEMICAL WEATHERING

DEPOSITIONAL PROCESSES

COLUVIATION

FLUVIAL

LACUSTRINE

ICE

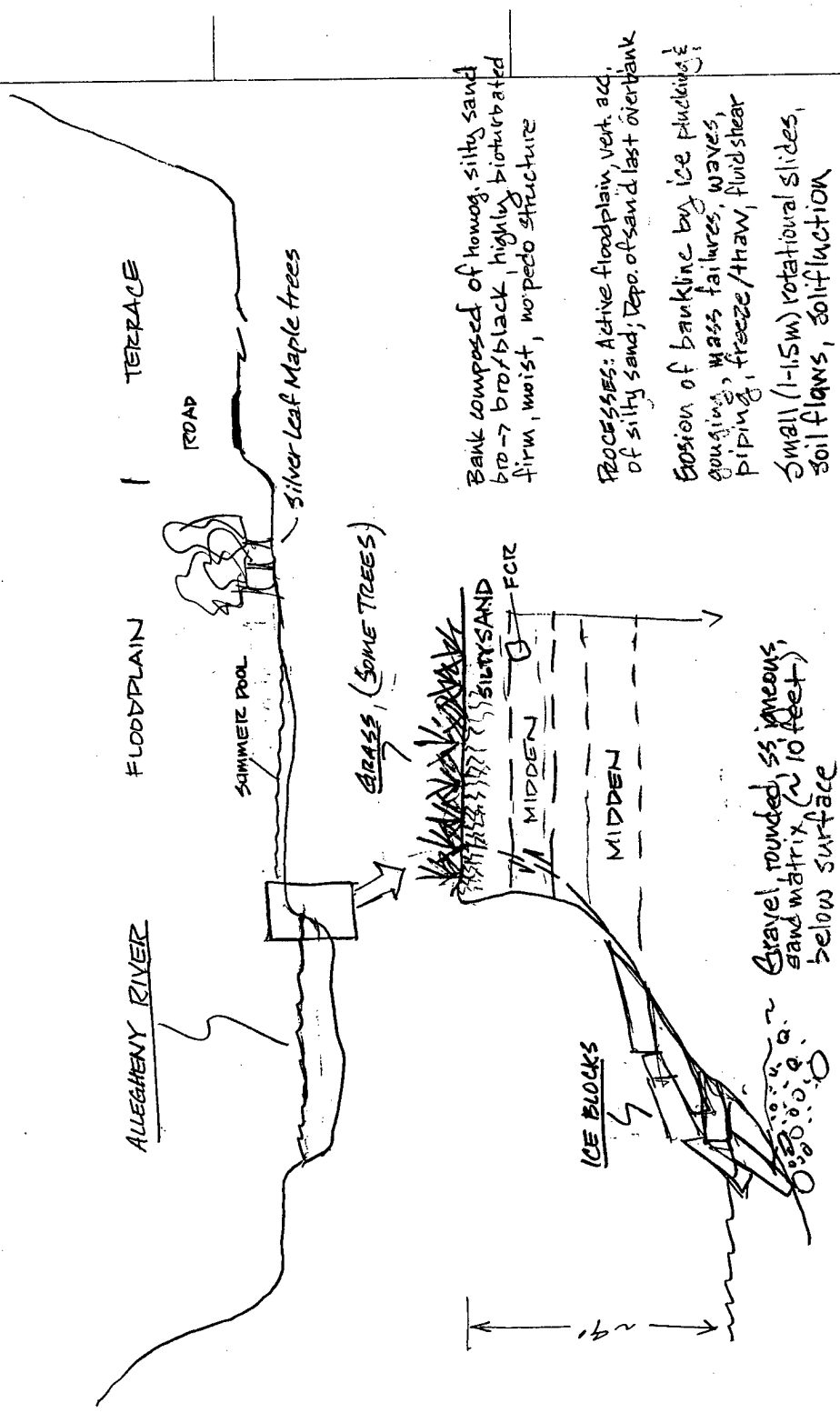
OTHER SITE DESTRUCTIONAL PROCESSES Frequently collected; some riparian tree-throws.

VEGETATION Eel grass, silver maple in clumps.

COMMENTS Ice is a major process of destruction.
Floodplain of vertical accretion deposits, several strata of midden.

See attached sketch

STEAMBURG SITES, ALLEGHENY RES. 3/13/96



**Appendix B
1987 Protection Alternatives
for the Riverview/Corydon
Cemetery at Allegheny
Reservoir, Pennsylvania**

US ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
WILLIAM S. MOORHEAD FEDERAL BUILDING
300 LIBERTY AVENUE
PITTSBURGH, PENNSYLVANIA 15222

30210-27-8
COPY

October 16, 1987

Mr. David Wright
Forest Supervisor
Allegheny National Forest
P.O. Box 647
Warren, Pennsylvania 16365

Dear Mr. Wright:

Enclosed for your review is an engineering study conducted on the erosion problem at the Corydon Cemetery at Allegheny Reservoir. This study was requested in a letter from your predecessor, Mr. Carpenter, dated November 17, 1986. The study proposes four alternative schemes for stabilizing the shoreline below the bluff on which the cemetery is located. All schemes involve the placement of stone riprap to absorb wave energy and prevent displacement of the sands and gravels which compose the bluff. They differ in the elevation of the lower limit of the protection and in the creation or omission of a small level berm which may be considered desirable. The estimated costs range from \$594,000.00 to \$784,000.00.

There is also the option of dealing with this problem as we have in the past. This would involve retaining the existing safeguards against vandalism and erosion at the site and properly reinterring any skeletal remains that may become exposed.

Once you have had the opportunity to review this study, representatives of the Forest Service and the Corps of Engineers should meet to discuss the alternatives presented in this letter. The issues of responsibility and funding status of any proposed long-term solution have yet to be addressed. Please contact Ms. Elisa Caravaglia, Resource Manager at Kinzua Dam, when you wish to arrange a meeting. The telephone number there is 814-726-9661.

Sincerely,

George M. Miller, Jr.
Colonel, Corps of Engineers
District Engineer

Enclosure

Copies Furnished:

✓ Kinzua Dam
Upper Allegheny Area Office
Chief, Engineering Division
Chief, ED-C
Chief, PD



Pittsburgh Engineering Consultants, Inc.

2275 SWALLOW HILL ROAD; BUILDING 400, PITTSBURGH, PA 15220

(412) 276-8200

July 8, 1987

Mr. Marshall Fausold, P.E.
Chief, Geotechnical Branch
U.S. Army Corps of Engineers
Federal Building, Room 1926
1000 Liberty Avenue
Pittsburgh, PA. 15222

Subject : Corydon Cemetery Erosion Protection
Allegheny River Reservoir at Willow Bay
Contract No. DACW59-86-D-0002
Delivery Order No. 5

Dear Mr. Fausold :

We are submitting herein four (4) copies of the final conceptual design study report with the following attachments for the captioned project.

1. Project Location Maps (2)
2. 1983 and 1986 Project Site Plans (Exhibits A-1 & A-2)
3. Sedimentation Range 27 Profiles Comparison between 1966, 1983 and 1986 Surveys
4. Typical Sections (5)
5. Determination of Stone Protection Requirement (2)
6. Estimate of Quantities (5)
7. Estimate of Construction Cost (2)

The comments in your letter of June 15, 1987 and at our meeting on June 24, 1987 have been considered and addressed in this final report.

Site Condition

We conducted an on-site reconnaissance on March 18, 1987 with Mr. Robert Cole, your Landscape Architect and Ms. Lisa Caravaglia, your Reservoir Manager, to become familiar with the subject project site and erosion problem.

Corydon Cemetery is located on a promontory at the confluence of the Willow Creek embayment with the main body of Allegheny River Reservoir. It is exposed to wave action at a wide range of reservoir elevations. The erosion is more prominent on the southwest side than on the south-east side.

The material of the streambank area is primarily composed of medium to coarse sand, gravelly sand and sandy gravel. We learned from your office that no test borings were taken at the project site and the bedrock may be assumed to be very deep.

Pittsburgh Engineering Consultants, Inc.

Civil • Environmental • Structural • Transportation

Mr. Marshall Fausold, P.E.
July 8, 1987
Page Two

After reviewing your furnished materials, the comparison of the 1983 and 1986 cross section surveys and particularly the profile for sedimentation monitoring between 1966 and 1983, there has been a continued loss of material from the Corydon Cemetery streambank. The most severely impacted area is between Elevations 1325 and 1345. Loss below Elevation 1318 or above Elevation 1350 is negligible.

This finding is supported by examination of your furnished drawings particularly Exhibits A-1, A-2 and C which we reproduced and attached in this report. The contour lines below Elevation 1320 between the Years of 1983 and 1986 are almost coincide and are further verified by comparison of the Sedimentation Range 27 profiles between 1966, 1983 and 1986 surveys.

Solutions

Structural solutions such as concrete retaining wall or soldier beam and lagging wall were not considered because they are far more expensive and incompatible with the recreational and serene setting of the project site environment. Stone protection for the streambank is appropriate and cost effective for this project.

Based on your design wave height of 3.5', we determine the required D-50 stone size is about 15" (PennDOT stone gradation R-7) and stone protection thickness is 36".

Given the site condition, the normal Winter low pool at Elevation 1292, the normal Summer high pool at Elevation 1328 and some exceptionally high pool elevation (from November, 1982 to January, 1983) reaching Elevation 1346.7, we feel stone protection should be given between Elevations 1320 and 1350.

Although the highest water elevation reached at Elevation 1362 during the brief Agnes Storm in June, 1972, we are of the opinion that stone protection above Elevation 1350 is not justified for this rare storm with recurrence interval estimated at between 50 to 100 years.

A total of five (5) alternates have been explored. Under each alternate, there will be minor excavation with the exception to secure a firm anchor at the toe trench with bottom Elevation varying from 1310 to 1316. In each case a stone dike will be built to Elevation 1332 to handle the normal

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Civil • Environmental • Structural • Transportation

Mr. Marshall Fausold

July 8, 1987

Page Three

high water elevation (Summer pool at Elevation 1928 + 4' to account for wave action).

As shown on the typical sections for each alternate studied, Scheme 1 creates a wide area on top of the stone protection. Approximately one acre of land can be reclaimed under this scheme.

Scheme 2 only attempts to provide basic stone protection without any land reclamation.

Scheme 3 offers a compromise between Schemes 1 and 2. Approximately one half acre of land is created under this scheme.

After discussion and meeting with your office, Schemes 4 and 5 were also explored.

Scheme 4 offers a compromise b 1 and 3. Approximately 0.75 acre of land can be reclaimed under this scheme.

Scheme 5 is a refinement of Scheme 2 with bottom toe trench moves down to Elevation 1310.

The estimated construction cost of the five alternates are :

Scheme 1	-----	\$621,000
Scheme 2	-----	\$596,000
Scheme 3	-----	\$640,000
Scheme 4	-----	\$680,000
Scheme 5	-----	\$784,000

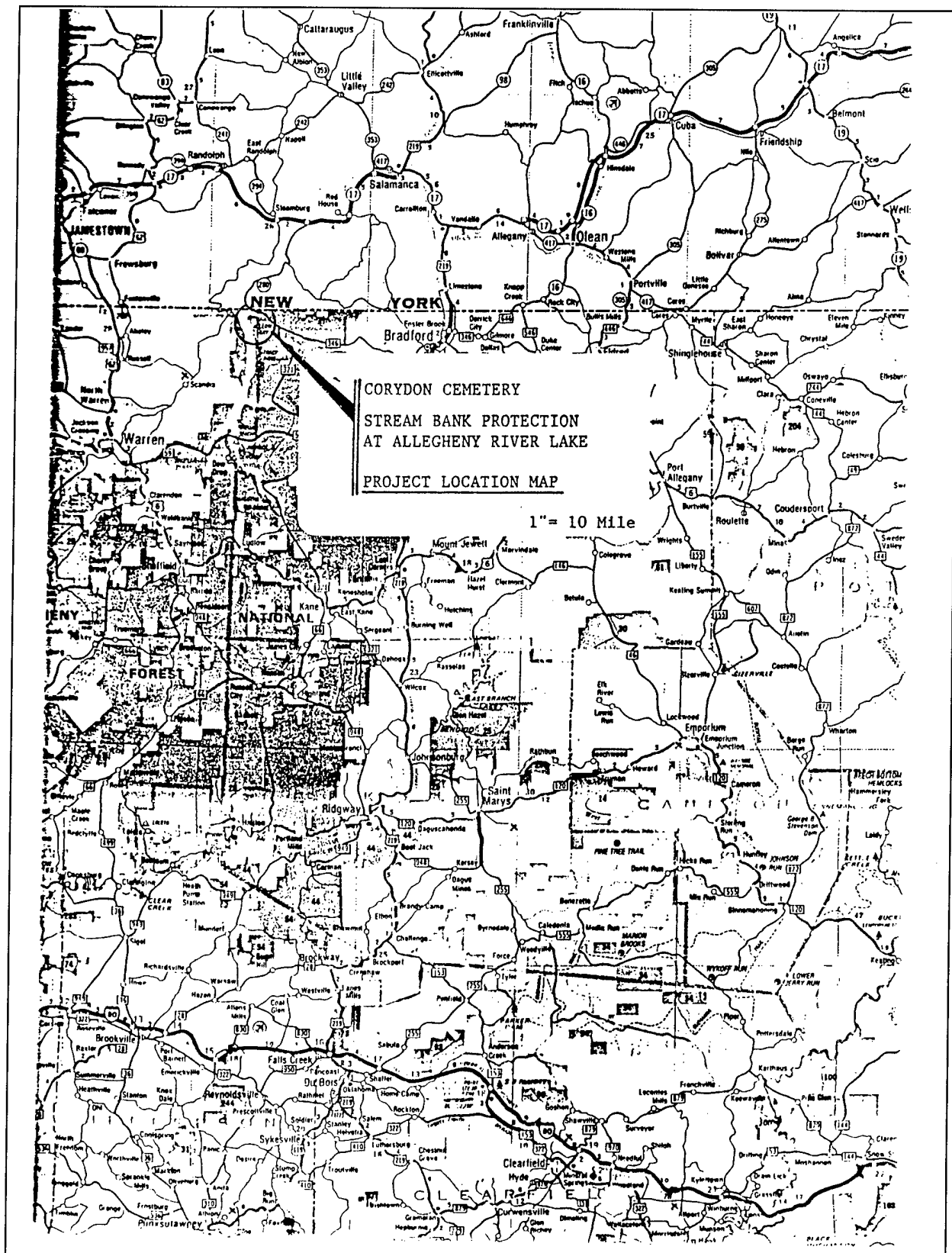
It has been a pleasure of working for your fine office on this project. Please advise us if you have any questions or require additional information in this final submission.

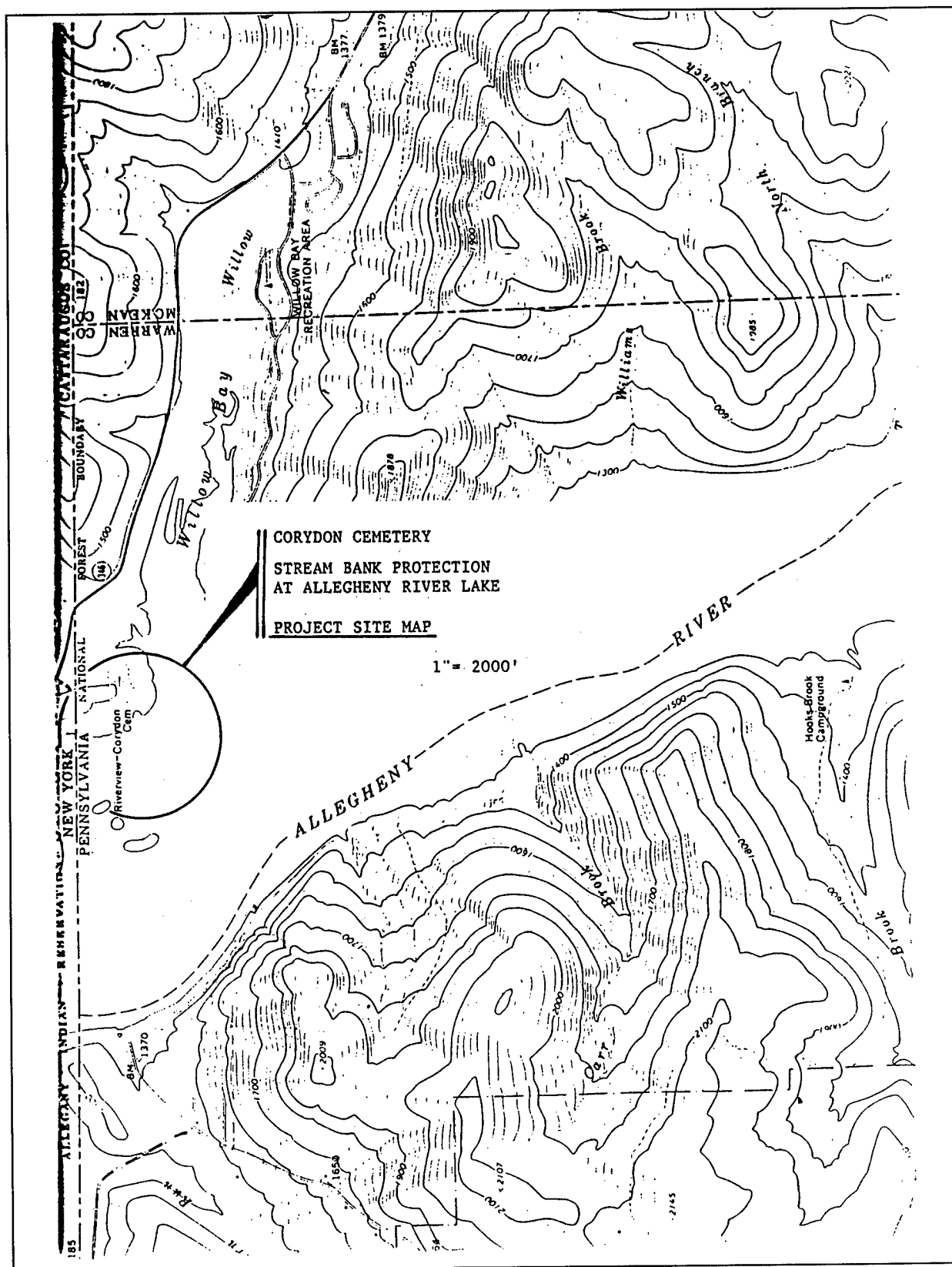
Very truly yours,



Patrick S. Au, P.E.
President

Enclosures





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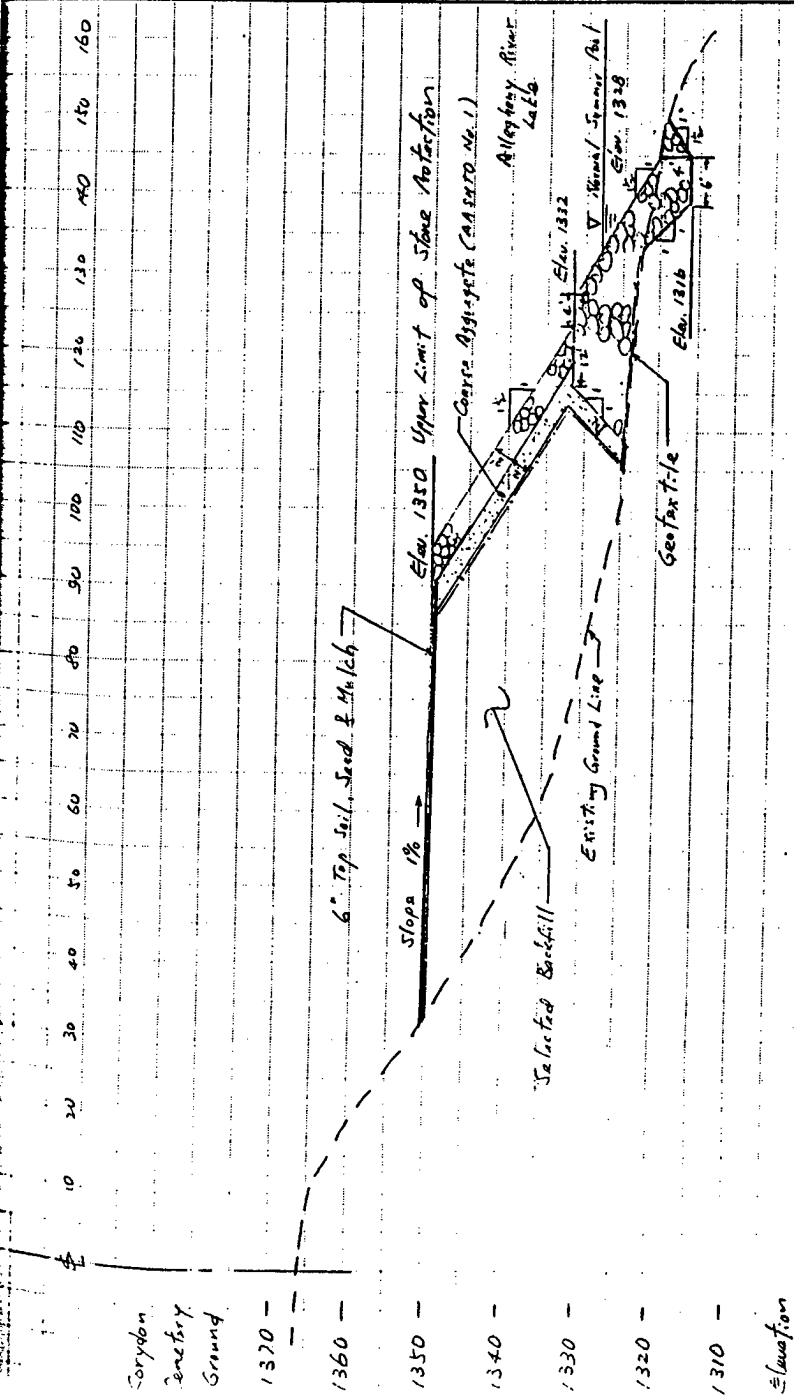
JOB Corydon Cemetery Erosion Protection

SHEET NO. 1 OF 5

CALCULATED BY ASR DATE 5-18-87

CHECKED BY _____ DATE _____

Typical Sections



ALTERNATE SCHEME NO. 1

Scale: 1"=20'

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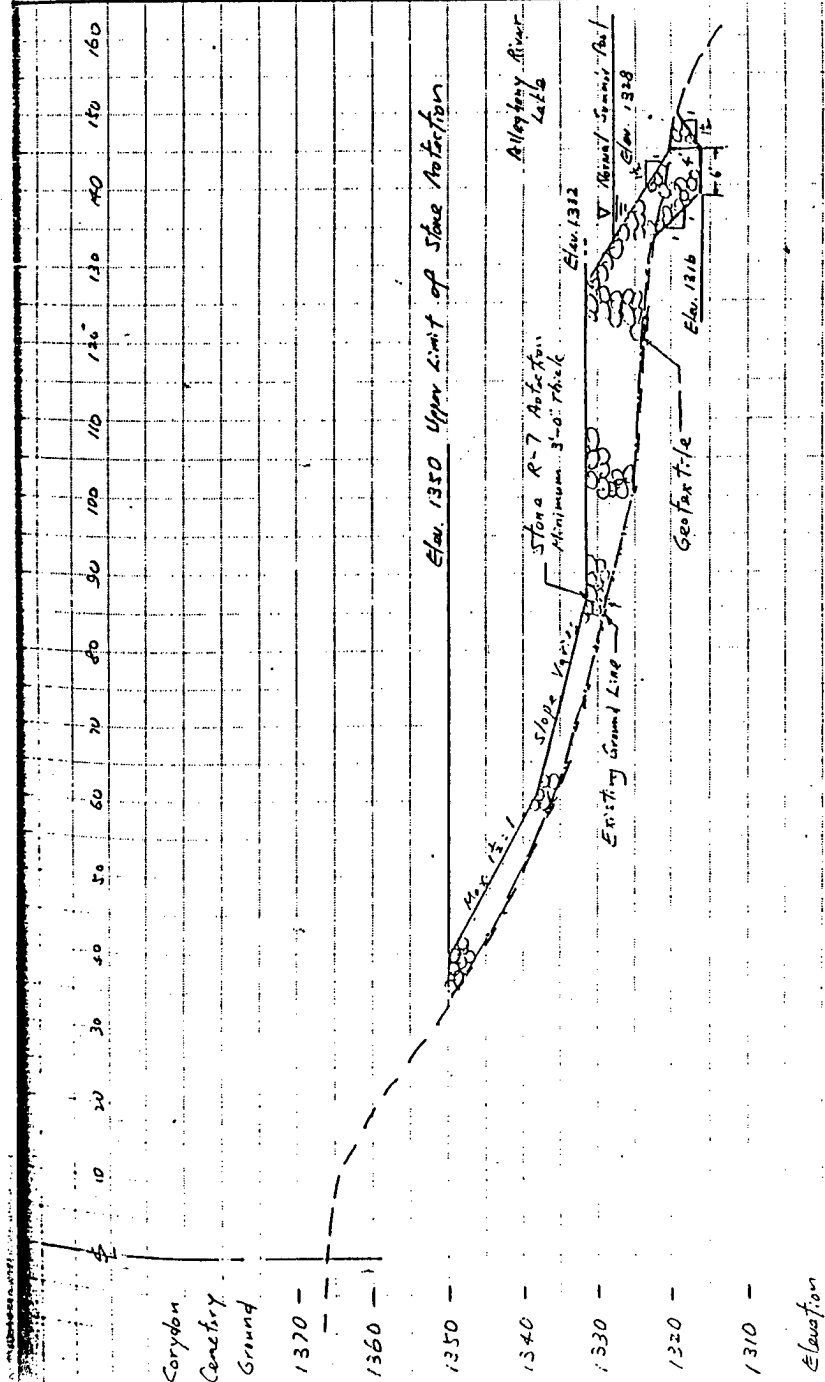
JOB Corydon Cemetery Cross Section

SHEET NO. 2 OF 5

CALCULATED BY ASR DATE 5-18-87

CHECKED BY _____ DATE _____

Typical Sections



ALTERNATE SCHEME NO. 2

Scale: 1"=20'

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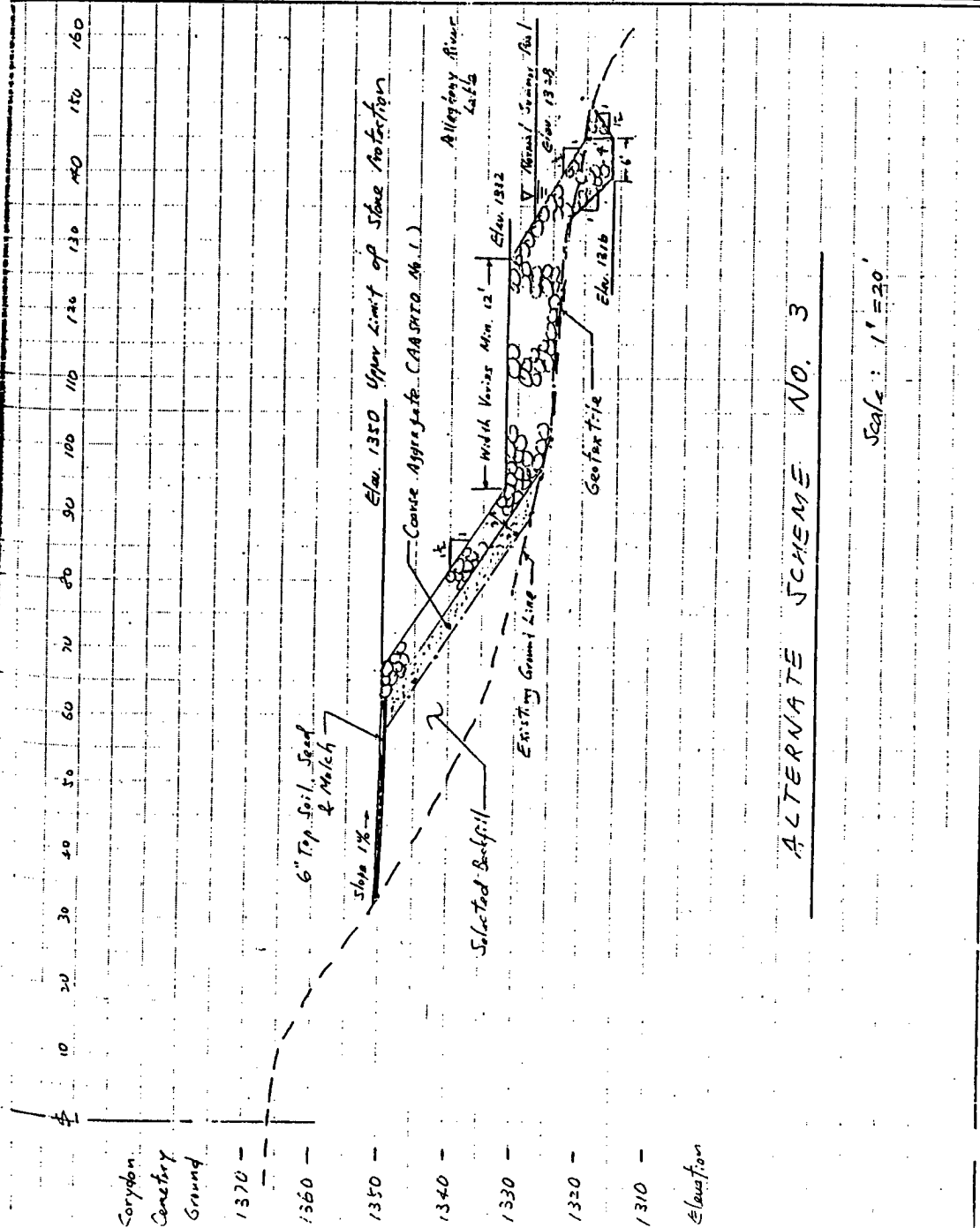
JOB Corydon Cemetery Erosion Protection

SHEET NO. 3 OF 5

CALCULATED BY ADK DATE 5-18-97

CHECKED BY _____ DATE _____

TYPICAL SECTIONS



ALTERNATE SCHEME NO. 3

Scale: 1"=20'

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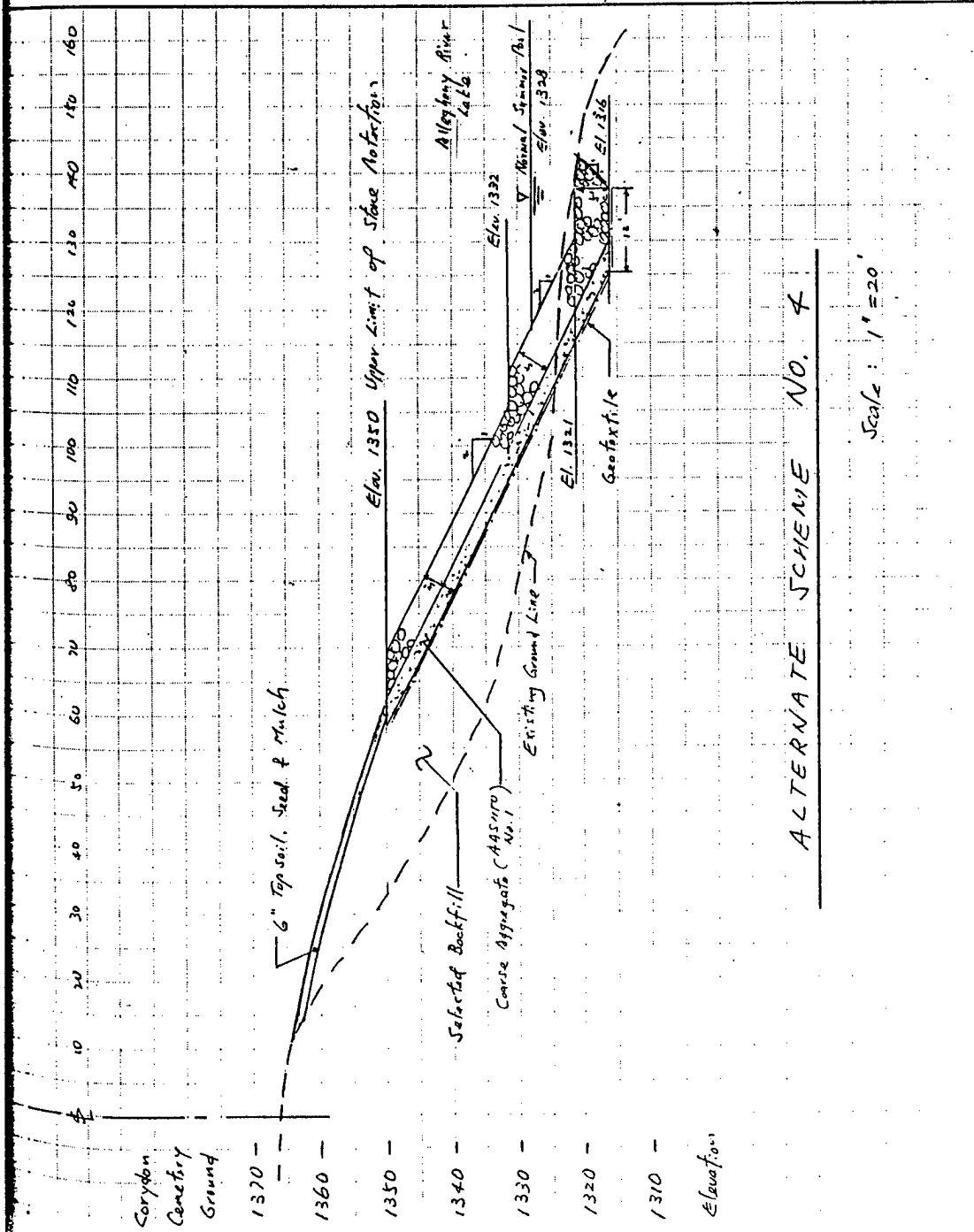
JOB Corydon Cemetery Erosion Protection

SHEET NO. 4 OF 5

CALCULATED BY [Signature] DATE 6-18-87

CHECKED BY [Signature] DATE 6-18-87

Typical Section

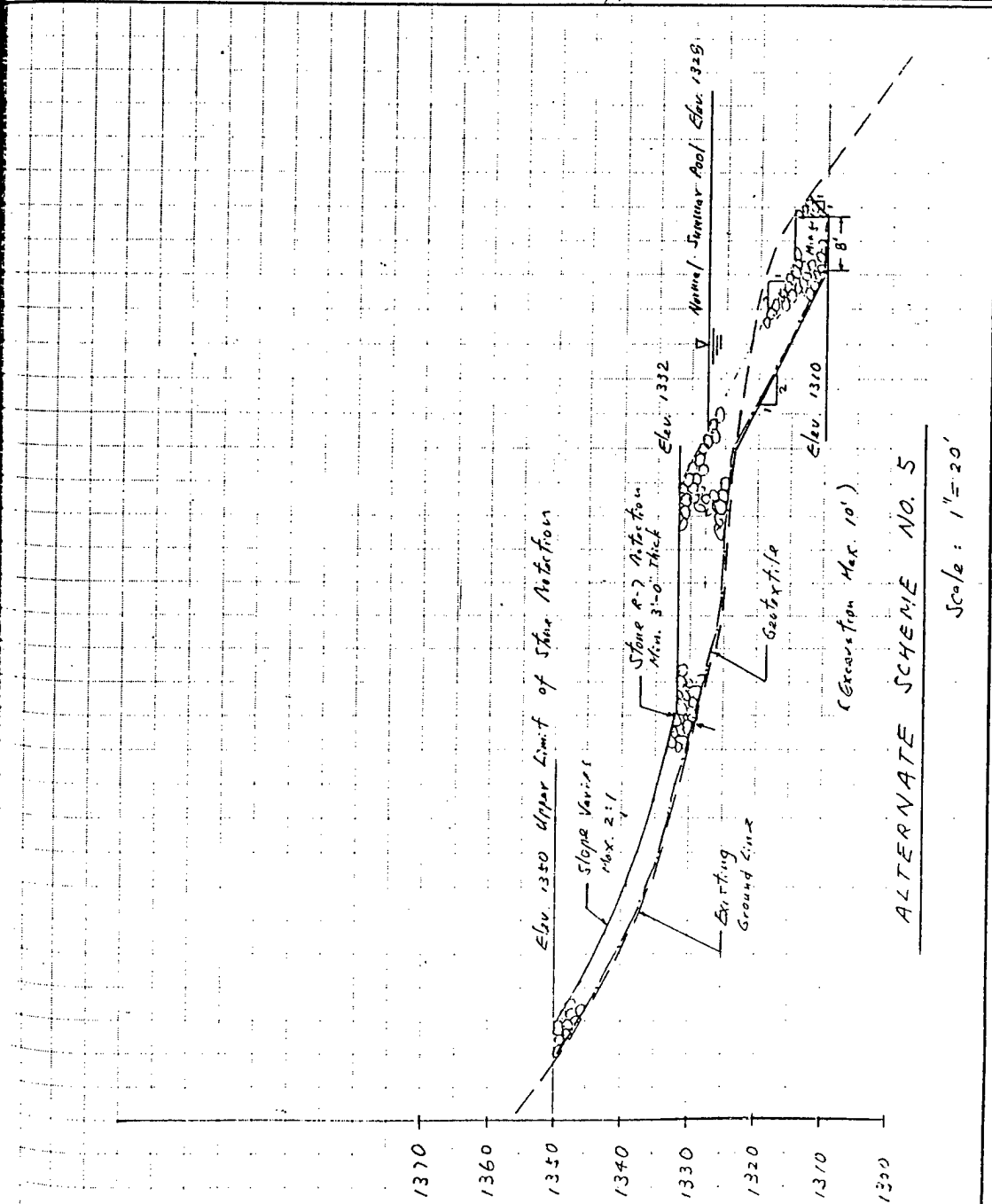


ALTERNATE SCHEME NO. 4

Scale: 1" = 20'

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JOB Corydon Cemetery
SHEET NO. 5 OF 5
CALCULATED BY rix DATE 7-6-57
CHECKED BY _____ DATE _____
SCALE Typical Section



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JOB Corydon Cemetery Erosion Protection

SHEET NO. 1 OF 2

CALCULATED BY gja DATE 5-20-87

CHECKED BY _____ DATE _____

SCALE _____

SUMMARY OF COST COMPARISON

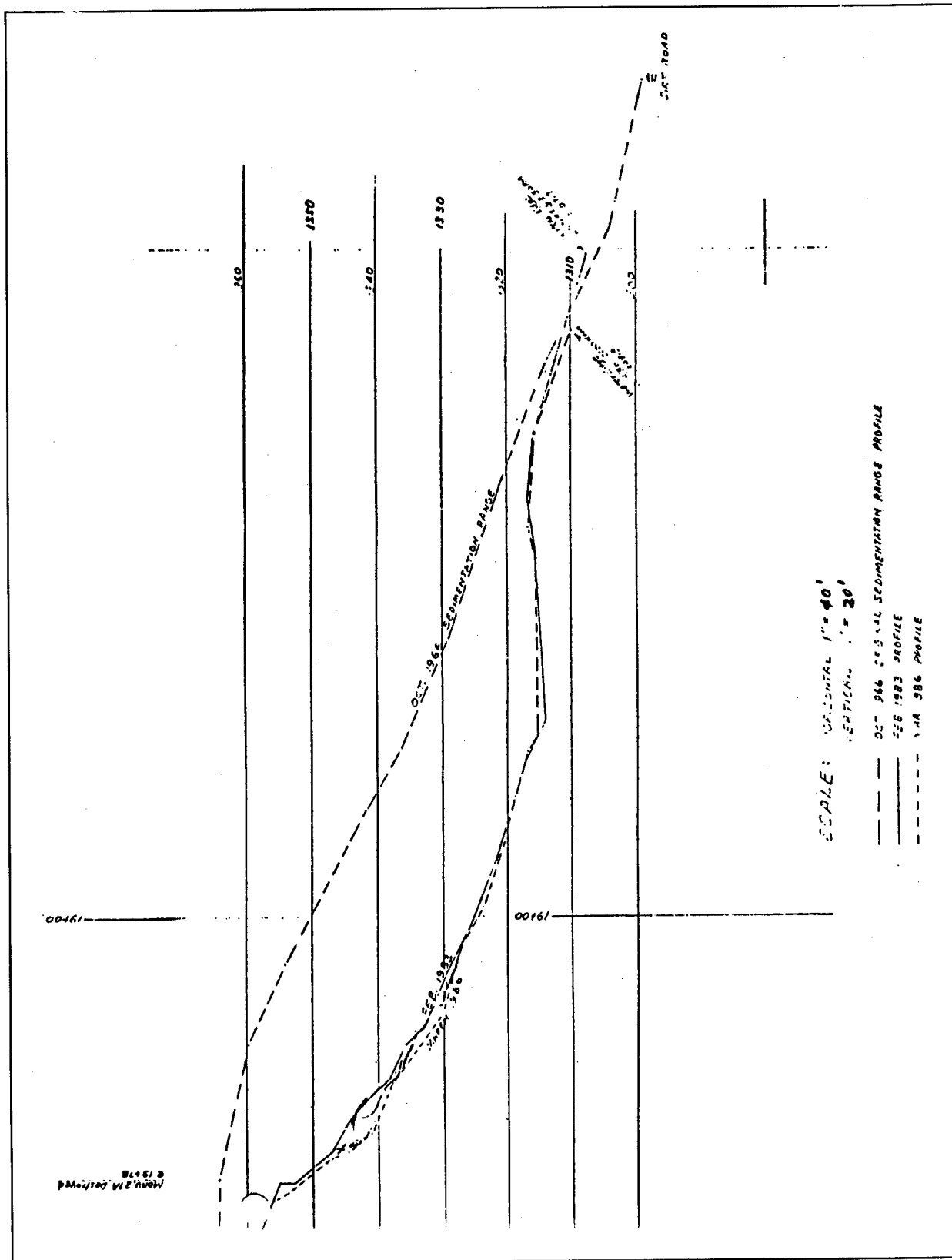
Pay Item Description	Unit	Unit Price	Scheme 1		Scheme 2		Scheme 3	
			Quantity	Cost	Quantity	Cost	Quantity	Cost
Unclassified Excavation	C.Y.	\$20.00	920	\$18,400	1,120	\$22,400	880	\$17,600
Coarse Aggregate (No. 1)	C.Y.	\$28.00	1,430	40,040			1,320	36,960
Solated Backfill	C.Y.	8.00	22,300	178,400			18,080	144,640
Stone Protection	C.Y.	45.00	6,460	290,700	10,680	480,600	7,770	349,650
Geotextile (Filter)	S.Y.	5.00	4,740	23,700	7,750	38,750	5,000	25,000
6" Top Soil (incl. Seed & Mulch)	S.Y.	3.00	4,320	12,960			2,460	7,380
Sub total				\$564,200		\$541,750		\$581,230
Plus 10% ± Allowance for Contingencies				56,800		54,250		58,770
Total Construction Cost				\$621,000		\$596,000		\$640,000

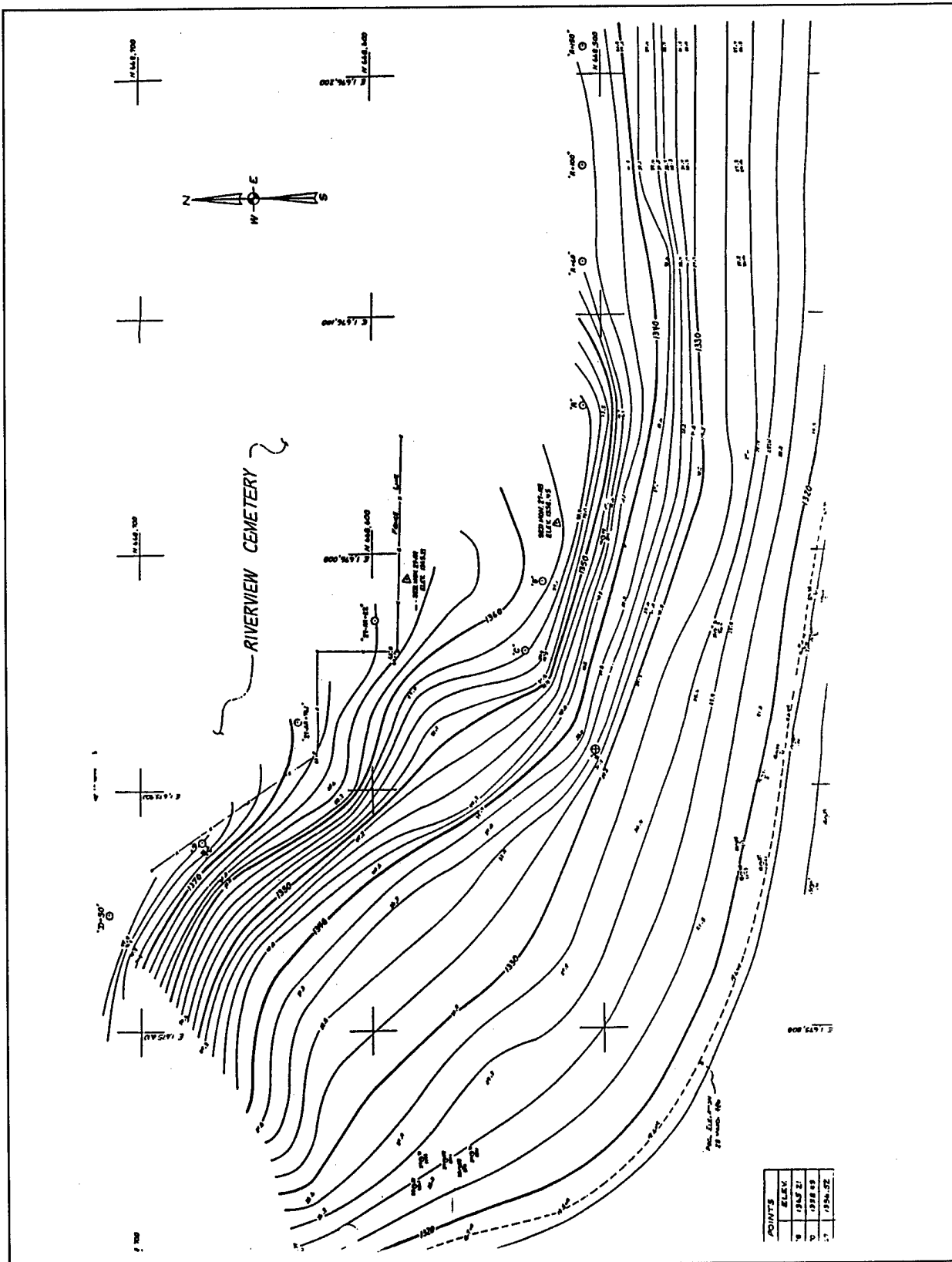
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JOB Corydon - Cemetery Erosion Repair
SHEET NO. 2 OF 2
CALCULATED BY EDR DATE 2-6-87
CHECKED BY _____ DATE _____
SCALE _____

SUMMARY OF COST COMPARISON

Pay Item Description	Unit	Unit Price	Scheme A		Scheme B	
			Quantity	Cost	Quantity	Cost
Unclassified Gravel	c.y.	\$20.00	2,840	\$56,800	9,320	\$186,400
Coarse Aggregate (No. 1)	c.y.	\$28.00	2,720	76,160		
Selected Backfill	c.y.	\$10.00	18,600	186,000		
Stone Autoclave	c.y.	\$45.00	5,800	261,000	13,350	600,750
Geotextile (Filter Fabric)	s.y.	\$5.00	5,440	27,200	9,130	45,650
6" Top Soil (incl. seed & mulch)	s.y.	\$3.00	3,660	10,980		
Sub total				\$618,140		\$712,800
Plus 10% Allowance for Contingencies				61,814		71,280
Total Construction Cost				\$680,000		\$784,080





REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1.AGENCY USE ONLY (Leave blank)		2.REPORT DATE September 1996	3.REPORT TYPE AND DATES COVERED Final report	
4.TITLE AND SUBTITLE Managing Historic Properties in Drawdown Zones at Corps of Engineers Reservoirs: Three Case Studies			5.FUNDING NUMBERS	
6.AUTHOR(S) Robert A. Dunn, Lawson M. Smith, Hollis H. Allen, Hugh M. Taylor				
7.PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Engineer Waterways Experiment Station 3909 Halls Ferry Road Vicksburg, MS 39180-6199			8.PERFORMING ORGANIZATION REPORT NUMBER Technical Report EL-96-14	
9.SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers Washington, DC 20314-1000			10.SPONSORING/MONITORING AGENCY REPORT NUMBER	
11.SUPPLEMENTARY NOTES Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.				
12a.DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b.DISTRIBUTION CODE	
13.ABSTRACT (Maximum 200 words) This report attempts to identify techniques for the effective management of historic properties (National Register eligible) which are annually subjected to impacts from reservoir drawdowns. Much of the discussion focuses on three case studies which were conducted at three Ohio River Division reservoirs during the winter drawdown period of 1996. The Corps reservoirs included Barren River Lake, Kentucky (Louisville District); Bluestone Lake, West Virginia (Huntington District); and Allegheny Reservoir, Pennsylvania and New York (Pittsburgh District). Management techniques observed at the nine Corps projects visited in 1995 are also discussed. Additional information on proposed management techniques has been incorporated from sponsored research now under way at the U.S. Army Engineer Waterways Experiment Station for other Corps Districts. Site evaluation strategies, cultural resources monitoring plans, the mitigation of adverse effect through the combined use of archaeological data recovery and site protection, the direct and indirect control of vandalism, and the preparation of drawdown zone protection plans are some of the major topics addressed.				
14.SUBJECT TERMS See reverse.			15.NUMBER OF PAGES 166	
			16.PRICE CODE	
17.SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18.SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19.SECURITY CLASSIFICATION OF ABSTRACT	20.LIMITATION OF ABSTRACT	

14. (Concluded).

Archaeological resources

Archaeology

Corps of Engineers

Cultural resources

CRM (Cultural resources management)

Data recovery

Drawdown zone

Electronic surveillance

Erosion control

Geomorphic processes

Geomorphology

Historic properties

Inundation

Monitoring plan

National Register of Historic Places

Remote sensing

Reservoirs

Site evaluation

Site preservation

Site protection

Site significance

Site stabilization

Visitor behavior